

VALVOLINE INSTANT OIL CHANGE PROJECT MANUAL



WILLISTON VALVOLINE INSTANT OIL CHANGE

Address

Williston, ND 58801

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SPECIFICATIONS

TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

SECTION	SPECIFICATION	PAGES
00010	Construction Contract	1-24
00010	Contract for Labor Services Agreement	1-11
00011	Contractor Performance Evaluation	1-8
00020	Sample Bid Invitation	1
00100	Instructions to Bidders	1-4
00120	Supplementary Instructions to Bidders	1
00222	Geotechnical Report	1
00310	Bid Proposal Form	1-4
00821	Equal Employment Opportunity Requirement	1-6
00822	Certificate of Liability Insurance – Sample Certificate	1
00833	Contractor Safety and Health Regulations	1
00834	General Fire Safety and Health	1-2

DIVISION 01 – GENERAL REQUIREMENTS

01011	General Conditions	1-13
01091	Reference Standards	1
01092	Abbreviations and Symbols	1-3
01220	Progress Meetings	1
01340	Shop Drawings, Product Data and Samples	1
01341	Project Coordination	1
01410	Inspection, Sampling and Testing Laboratory Services	1- 4
01500	Temporary Utility Services	1
01540	Project Security & Protection	1 - 2
01610	Delivery, Storage and Handling	1
01700	Project Closeout	1

DIVISION 02 – EXISTING CONDITIONS

02060	Demolition	1 - 5
02110	Site Clearing	1 - 3
02330	Benchmark and Survey	1

DIVISION 03 – CONCRETE

03100	Concrete Formwork	1 - 2
03200	Concrete Reinforcement	1 - 3
03300	Cast-In-Place Concrete	1 - 13
03500	Pre-cast / Pre-stressed Concrete	1 - 3

DIVISION 04 – MASONRY

04200	Unit Masonry	1 - 15
04211	Thin Brick Veneer System	1 - 4
04720	Cast Stone Masonry	1 - 6

DIVISION 05 – METALS

05120	Structural Steel	1 - 4
05210	Steel Joists	1 - 3
05310	Steel Deck	1 - 3
05400	Light Gauge Metal Framing	1 - 7
05500	Metal Fabrications	1 - 5
05600	Miscellaneous Metal Work	1 - 3

DIVISION 06 – WOOD AND PLASTICS

06100	Rough Carpentry	1 - 8
06160	Sheathing	1 - 4
06175	Open Web Trusses	1 - 4
06200	Finish Carpentry	1 - 4
06240	Cabinet Work	1 - 3
06640	Plastic Paneling	1 - 3

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07132	Pre-Applied Sheet Membrane Waterproofing	1 - 5
07133	Self-Adhering Sheet Waterproofing	1 - 4
07150	Dampproofing	1 - 2
07190	Masonry Water Repellants	1 - 3
07210	Building Thermal Insulation	1 - 5
07241	Exterior Insulation Finish Systems (EIFS)	1 - 9
07271	Air/Moisture Barriers	1 - 9
07310	Shingle Roofing	1 - 3
07545	Thermoplastic Polyolefin Roofing (TPO)	1 - 4
07610	Architectural Metal Roofing System	1 - 5
07620	Sheet Metal Flashing and Trim	1 - 3
07720	Roof Accessories	1 - 5
07900	Joint Sealants	1 - 8

DIVISION 08 – OPENINGS

08110	Hollow Metal Doors and Frames	1 - 7
08305	Access Doors	1 - 3
08360	Overhead Doors	1 - 4
08410	Aluminum Framed Entrances and Storefronts	1 - 6
08710	Door Hardware	1 - 9
08800	Glass and Glazing	1 - 6

DIVISION 09 – FINISHES

09220	Portland Cement Plastering	1 - 5
09250	Gypsum Wallboard	1 - 3
09300	Tile	1 - 4
09510	Acoustic Panel Ceilings	1 - 4
09650	Resilient Flooring	1 - 2

09651	Epoxy Flooring	1 - 2
09670	Self-leveling Flake Flooring	1 - 8
09671	Self-leveling Quartz Flooring	1 - 8
09680	Carpet	1 - 2
09901	Corrosion Protection	1 - 10
09910	Exterior Painting	1 - 5
09920	Interior Painting	1 - 7
09930	Staining and Transparent Finishing	1 - 3

DIVISION 10 – SPECIALTIES

10261	Corner Wall Protection	1 - 2
10262	Bumper Guards	1 - 2
10430	Exterior Signs	1 - 4
10440	Non-illuminated Panel Signs	1 - 4
10505	Metal Lockers	1 - 1
10522	Fire Extinguishers	1 - 2
10810	Toilet Accessories	1 - 2

DIVISION 11 – EQUIPMENT

11132	Tire Rotation Lifts	1 - 3
11146	Lubrication Equipment	1 - 5
11147	Above Ground Tanks	1 - 4
11302	Underground Pre-Cast Oil / Water Separators	1 - 6
11303	Above Ground Oil / Water Separators	1 - 6

DIVISION 22 – PLUMBING SEE MECHANICAL SPECS

22050	Common Work Results for Plumbing	1 - 9
22052	Hangers and Supports For Plumbing Piping and Equipment	1 - 9
22053	General Duty Valves for Plumbing Piping	1 - 24
22054	Vibration and Seismic Controls For Plumbing Piping and Equipment	1 - 8
22070	Plumbing Insulation	1 - 15
22111	Domestic Water Piping	1 - 19
22131	Sanitary Waste and Vent Piping	1 - 11
22132	Sanitary Waste Piping Specialties	1 - 9
22141	Facility Storm Drainage Piping	1 - 9
22142	Storm Drainage Piping Specialties	1 - 6
22330	Domestic Water Heaters	1 - 8
22400	Plumbing Fixtures	1 - 10

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

23050	Common Work Results for HVAC	1 - 9
23051	Common Motor Requirements for HVAC	1 - 2
23052	Expansion Fittings and Loops for HVAC Piping	1 - 5
23053	General Duty Valves for HVAC Piping	1 - 25
23054	Hangers and Supports for HVAC Piping and Equipment	1 - 9
23055	Vibration and Seismic Controls For HVAC Piping and Equipment	1 - 10
23056	Testing, Adjusting and Air Balancing for HVAC	1 - 10
23070	HVAC Insulation	1 - 16

SEE MECHANICAL SPECS

23112	Facility Natural Gas Piping	1 - 19
23311	Metal Ducts	1 - 12
23330	Air Duct Accessories	1 - 7
23371	Diffusers, Registers and Grilles	1 - 3
23740	Split-System Air Conditioners	1 - 9
23741	Packaged, Outdoor, Central-Stationed Air Handling Units	1 - 10
23750	Infrared Radiant Tube Heaters	1 - 5
23770	HVAC Power Ventilators	1 - 4

DIVISION 26 – ELECTRICAL

SEE ELECTRICAL SPECS

26050	Basic Electrical Requirements	1 - 9
26051	Basic Electrical Materials and Methods	1 - 8
26052	Grounding and Bonding for Electrical Systems	1 - 5
26053	Raceways and Boxes for Electrical Systems	1 - 6
26054	Vibration and Seismic Controls for Electrical Systems	1 - 4
26055	Identification for Electrical Systems	1 - 5
26092	Lighting Control Devices	1 - 5
26241	Switchboards	1 - 6
26242	Panelboards	1 - 6
26272	Wiring Devices	1 - 4
26281	Fuses	1 - 2
26282	Enclosed Switches and Circuit Breakers	1 - 5
26291	Enclosed Controllers	1 - 5
26510	Interior Lighting	1 - 5
26560	Exterior Lighting	1 - 5
DIVISION 27 – COMMUNICATIONS		
27130	Voice and Data Communications Cabling	1 - 5

DIVISION 31 – EARTHWORK

31000	Earthwork	1 - 5
31100	Site Clearing	1 - 4
31231	Rock Removal	1 - 4
31330	Geotextiles / Geomatrixes	1 - 2

DIVISION 32 – EXTERIOR IMPROVEMENTS

32120	Asphalt Paving	1 - 5
32130	Portland Cement Concrete Pavement	1 - 11
32160	Concrete Curbs and Gutters	1 - 3
32165	Segmental Concrete Retaining Wall	1 - 3
32312	Fences and Gates	1 - 3
32930	Landscaping	1 - 8
32950	Irrigation Systems	1 - 4

DIVISION 33 – UTILITIES

33310	Drainage Pipe & Fittings for Sewers	1 - 11
33391	Manholes, Frames and Covers for Sewers	1 - 4
33462	Geotextile Subsurface Drainage Filtration	1 - 1

CONSTRUCTION CONTRACT

This CONSTRUCTION CONTRACT (“Contract”) is made as of the _____ day of _____, 20__, by and between _____, a _____, having an address of _____ (the “Contractor”), and VALVOLINE INSTANT OIL CHANGE, a business of Valvoline LLC, a Delaware limited liability company having an address of 100 Valvoline Way, Lexington, Kentucky 40509 (the “Owner”).

RECITALS:

WHEREAS, the Owner is the [owner/lessee] of that certain property located in the City of _____, County of _____, State of _____, with an address of _____; on which Owner [operates/intends to operate] a “Valvoline Instant Oil Change Facility” (the “Project”); and

WHEREAS, the Owner has retained _____ to prepare certain architectural and engineering drawings, plans and specifications for the Project, a copy of which are attached hereto as EXHIBIT A (as the same may be amended from time to time in accordance herewith, the “Plans and Specifications”); and

WHEREAS, the Owner has agreed to retain the Contractor, and the Contractor has agreed, to perform all work necessary to complete the project depicted in the Plans and Specifications on the terms and conditions set forth herein.

NOW THEREFORE, for and in consideration of good and valuable consideration, the receipt of which is hereby acknowledged, the Contractor and the Owner covenant and agree as follows:

I. EXECUTION.

This Contract shall be signed in duplicate by the Contractor, and signed and witnessed in duplicate by the Owner. By executing the Contract, the Contractor represents that an authorized representative of the Contractor has visited the site, become familiar with the local conditions under which the Work (as defined below) is to be performed and correlated its observations with requirements of this Contract.

2. CONSTRUCTION SITE DESCRIPTION.

The construction site is depicted in EXHIBIT A attached hereto. EXHIBIT A may include a survey depicting the site and a site plan depicting the Project as it is intended to appear following completion of the Work by the Contractor.

3. SCOPE OF WORK.

(a) The Contractor shall furnish and pay for all labor, materials, power, equipment, transportation, and all other items unless otherwise stipulated, necessary to complete the work and complete the Project as depicted in the Plans and Specifications (the “Work”). Where one or more certain materials, trade names, or articles of any certain manufacturer are mentioned in the Plans and Specifications, it is done for the express purpose of establishing a basis for durability, quality and efficiency, and variations from the Plans and Specifications are unacceptable, and other materials may be used only if (i) they are equal in durability, quality and efficiency to those mentioned in the Plans and Specifications and are in harmony with the Work and (ii) the Owner has given its prior written approval of any such variation. Should any work which is not detailed herein be required in order to properly complete the Work to be done hereunder, including any Work reasonably inferable from the Plans and Specifications, the Contractor shall perform all such work as if fully described herein.

(b) The Contractor or its designated representative shall, during the progress of the Work, be in attendance at the Project site for the purpose of supervising the Work as often and for as long as commercially reasonable. The Contractor shall carefully study and compare all Plans and Specifications or interpretations thereof. Unless otherwise specified in the Plans and Specifications, all materials shall be new and both workmanship and materials shall be of good quality. The Contractor shall, if required, furnish satisfactory evidence to the Owner as to the kind and quality of materials.

(c) The Contractor shall maintain for Owner one copy of all Plans and Specifications, Contract Addenda, shop drawings, Field Work Orders, Change Orders and other modifications, in good order and marked to record all changes made during construction as applicable for the scope of work of the Project. No portion of Work requiring a shop drawing or sample submission shall be started until the submission has been approved by Owner in writing. The Contractor shall be held responsible for all mistakes or errors in shop drawings or samples.

4. PERMITS, LICENSES AND FEES.

The Contractor shall secure all trade permits and licenses necessary for the accomplishment of the Work and shall comply with all local laws and regulations (“Legal Requirements”) and, if anything herein contained is at variance with any Legal Requirement, then the Contractor shall immediately notify the Owner and receive written instructions before proceeding with such Work. Prior to Contractor’s application for a building permit, it shall secure Owner’s written approval of the project value to be used for permit purposes. The building permit and curb cut permit will be issued to the Contractor. The costs of such permits will be Owner's responsibility. At Owner’s option, Owner may obtain any of the licenses or permits

5. WARRANTY.

Contractor guarantees and warrants that the Work shall be in compliance with all Legal Requirements; and that the Work shall be free from defects as determined by Owner. Any Work not in conformance with this guarantee shall be considered defective (“Defective Work”).

(a) Contractor agrees to repair or replace, at Owner's option, any Defective Work (including, without limitation, materials) for the later of: (i) the minimum time period as may be prescribed by local statute, law or regulation whether provided for in the Contract or not, or (ii) a period of one (1) year from Final Completion or correction of all defects and punch-list items to Owner's satisfaction, unless a longer period is stated in the Plans and Specifications (collectively referred to as the "Warranty Period"). If Defective Work is latent, hidden or not normally observable, the Warranty Period shall extend for such period as may be specified under state or local law, and if no such period is specified, then such period shall extend for one (1) year from discovery of such Defective Work by the Owner. Within a reasonable time after written notice of a defect, Contractor shall remedy and repair any defects in materials or workmanship, without expense to Owner, including damage to other work and repair or reimbursement for all damages resulting therefrom.

(b) The Contractor agrees to meet with Owner and/or Owner's representative within fourteen (14) days of the end of the eleventh month following Final Completion for an inspection of the Work to address any warranty issues. If Contractor fails to meet with Owner within said period, the Warranty Period shall be extended until the parties meet and Contractor has addressed such warranty issues. All deficiencies not caused by Owner, neglect, failure to maintain or normal wear and tear shall be noted, and a list of deficiencies shall be given to Contractor. Contractor agrees to correct all such deficiencies within thirty (30) days after the date of the meeting. If the deficiencies are not corrected, Owner may hire an independent contractor to do the Work and bill the Contractor. Contractor agrees to promptly reimburse Owner for its costs to correct the deficiencies. If any item cannot, with reasonable due diligence, be corrected within thirty (30) days, Contractor agrees to set forth in writing a reasonable schedule for completion of the Work that is acceptable to Owner. If such schedule is not met, Owner may complete the Work and Contractor shall promptly reimburse Owner for its costs to complete the Work.

(c) Final payment, use of the improvements, or any other act of Owner shall not relieve the Contractor of his responsibility for latent or patent defects, faulty workmanship or materials. Owner agrees to give notice of observed defects with reasonable promptness.

(d) The Contractor shall have each subcontractor execute and deliver to Owner upon the earlier of (a) Final Completion; or (b) termination of the Contract, a written guarantee covering all work not performed by the Contractor and not guaranteed by any other party. The guarantee shall be for the Warranty Period. All third-party guarantees and warranties for the building materials and mechanical equipment included in the Project, and supplied by the Contractor, if any, such as, but not limited to, roofing system, electrical systems, plumbing systems, all mechanical equipment, the hot water heater, sump pump, H.V.A.C units, exhaust fans, door closures and water softeners and all other equipment and material with a guarantee, shall be delivered to Owner by the Contractor.

6. CONTRACT TIME.

(a) Attached hereto as EXHIBIT B is a current schedule for the completion of the Work (as the same may be amended from time to time, the "Project Schedule"), which schedule includes a date on which Owner intends to issue a written "Notice to Proceed" with the Work (the date actually set forth in such Notice to Proceed shall be referred to herein as the "Start Date"), and a date on which the Contractor shall achieve Substantial Completion of the Work (such period from the Start Date to the Substantial Completion date, as the same may be amended from time to time, the "Contract Time"). Contractor agrees that time is of the essence with respect to Contractor's obligations hereunder. The Contractor shall staff the site and commence Work on the Start Date. If the Work is not commenced by the Contractor on the Start Date, the Owner reserves the right to terminate this Contract without payment of any funds to the Contractor.

(b) In no event shall Contractor commence the Work prior to receiving a Notice to Proceed. In the event Contractor commences construction without a Notice to Proceed, Owner shall be entitled to the amount of its any damages and expenses related thereto, and the Contractor shall immediately cease the Work.

(c) Owner may at any time prior to issuing the Notice to Proceed to the Contractor, terminate this Agreement without any obligation to the Contractor.

(d) Contractor agrees that if Substantial Completion of the Work is not achieved within the Contract Time, Owner will suffer substantial and irreparable damages and lost profits, rents, taxes and other costs which may be difficult to ascertain at this time or at the time of loss. Contractor therefore agrees that Owner shall be entitled to a credit against the Contract Sum for \$ _____ per day as liquidated and ascertained damages for every day beyond the time for completion or extended time, as the case may be, during which Contractor's Work shall remain unfinished. Such damages may be deducted by Owner from any monies due Contractor, or Owner may prosecute its claim against Contractor in any court of law or equity. The parties acknowledge and agree that the purpose of this provision is to reimburse Owner for damages that it will incur that are reasonable and probable, and not as a penalty or to obtain a windfall.

(e) As used herein, the term "Substantial Completion" shall mean that the Work is completed such that Owner determines it may occupy or use the Project and the Work for the use for which it is intended, subject only to the completion of the punch list and the other items required in connection with Final Completion (as defined below).

7. PAYMENT.

(a) In consideration for the Contractor undertaking and performing the Work to be done hereunder, Owner agrees to pay the Contractor the sum of _____ Dollars (\$ _____) (as the same may be amended from time to time, the "Contract Sum"). Attached hereto as EXHIBIT C is a line item breakdown of the Contract Sum amongst various components of the Work. The Contract Sum includes and Contractor shall pay, all federal, state, and local taxes, including sales taxes, excise taxes, use taxes, retailer's occupational taxes employment taxes, worker's compensation, overhead, and similar taxes.

(b) Where the Contract Sum is less than \$100,000.00 Owner will not make more than two (2) progress payments to the Contractor for the proportionate part of the Work actually performed to the date of the progress payment. The first progress payment may be requested when 50% of the Work is completed, as reasonably determined by Owner, and Owner shall pay 90% of such Contractor's invoice, with the remaining ten percent withheld as retainage by Owner until Substantial Completion has been achieved. The final progress payment shall be requested within thirty (30) days after Substantial Completion.

(c) Where the Contract Sum is \$100,000.00 or more, Owner will not make more than four (4) progress payments to Contractor for the proportionate part of the Contractor's work actually performed to the date of a request for a progress payment, less the aggregate of all previously approved requests. The first three progress payments may be requested at twenty-five percent (25%), fifty percent (50%), and ninety percent (90%) of completion of the Work, as reasonably determined by Owner; the final progress payment shall be requested within thirty (30) days after Substantial Completion has been achieved. Owner will pay no more than ninety (90%) of the amount due Contractor on account of progress payments, with the remaining ten percent withheld as retainage by Owner until Substantial Completion has been achieved.

(d) All invoices shall be accompanied by such supporting evidence as Owner may require, and shall show separately on their face a breakdown of labor, material costs, freight, if any, and sales tax, if any, covered by such invoice. Before a progress payment is made, Contractor must deliver to Owner a completed contractor's sworn statement and lien waiver (on such form as is acceptable to Owner and in accordance with local and state law) signed and sworn to by Contractor; and completed lien waiver forms (partial or final as may be applicable) signed and sworn to by all subcontractors and materialmen who furnish any part of the Work.

(e) Owner's obligations to the Contractor shall be limited to the payment for labor, materials and supervision actually furnished by the Contractor under the terms of this Contract. All requests for progress payments and final payment shall be submitted to Owner signed by an authorized representative of the Contractor.

(f) Final payment may be requested when the store is open, all unfinished construction items (*i.e.*, the punch list) completed, and the following items, in form and substance satisfactory to Owner, have been delivered to and approved by Owner (collectively, "Final Completion"):

- (i) a completed form Contractor's sworn statement and final lien waiver signed and sworn to by Contractor and completed final lien waiver forms signed and sworn to by all subcontractors and materialmen who furnish labor and/or materials;
- (ii) written releases (in recordable form) acceptable to Owner from any party that furnished labor, materials or equipment in connection with the Work and who filed liens against the property;

(iii) all required guarantees and certifications in accordance with the terms and conditions of this Contract, specifically including but not limited to any asphalt paving certificate (certifying sub-base, base, surface preparation and application), engineer's inspection report (certifying all concrete work to include mix design and reinforcing), roof warranty, and electrical certification;

(iv) any other affidavit, release, waiver notice, certificate or document that may be required by any governmental authority to permit the full use, occupancy and enjoyment of the demised premises and the improvements constructed by Contractor; and

(v) an as-built site plan noting all underground utilities and their location and a co-signed set of plans for use on the Premises, and if the Work is new construction, a rebuild or if the outside building dimensions or footprint have changed, an updated as-built site plan in duplicate, along with a binder containing all project related documents such as warranties, permits, photos, shop drawings, equipment information, final inspection reports.

All items required in connection with Final Completion shall be completed and submitted no later than thirty (30) days after the opening of the Project by Owner for business to the public.

(g) All requests for payment received and approved by Owner will be paid within thirty (30) calendar days after receipt by Owner. Owner shall in its sole discretion, have the right and option to make any and all payments by checks payable to Contractor and subcontractors and material suppliers jointly.

(h) If a Legal Requirement requires Owner to withhold certain monies from Contractor for tax purposes, Owner is hereby authorized by Contractor to withhold such payments from each progress payment and forward the same to the proper authority as required by law.

(i) Contractor shall pay all subcontractors and materialmen in a timely manner so that no claims for mechanic's or materialmen's liens will be filed against the Project. If Owner receives a notice of a claim to be filed or if a claim is filed against the Project, Owner shall have the right, but not the obligation, after five (5) days written notice to Contractor, to immediately pay the full amount of any such claim or lien directly to the subcontractor or materialmen and deduct the same from the Contract Sum. Contractor waives any and all claims or causes of action he has or may have against Owner for the payments which are made under this article. Owner shall have the right and option to require Contractor to provide Owner with a bond or title insurance indemnity acceptable to Owner insuring over a lien in an amount equal to at least one and one half times the amount of any such lien filed or notice of lien, including an amount sufficient to cover Owner's legal fees, interest and increased costs and expenses to enforce this Contract as an alternative to payment by Owner, where Owner is satisfied that a legitimate dispute exists concerning the sums due

to a subcontractor or materialmen. However, Contractor shall promptly defend a claim to conclusion in order to avoid long outstanding claims. By requiring such a bond or title insurance indemnity, Owner waives no rights it has against Contractor to require payment of a lien or to pay a lien itself.

(j) Contractor must meet with Owner within fourteen (14) days after Substantial Completion of the Work to agree on a formal list of construction deficiencies (called the “punch list”). Owner may withhold from the final progress payment an amount equal to one and one half (1½) times Owner’s estimated value of the Work described on the punch list. Contractor further agrees that all punch list items will be corrected within thirty (30) calendar days after the establishment of the punch list. If these deficiencies are not corrected within thirty (30) calendar days, Owner may hire an independent contractor to do the Work, and Owner may deduct its costs from the monies retained from Contractor, and/or Owner may bill Contractor for these costs or any shortages in the event the amount withheld is insufficient to complete the Work. Contractor agrees to pay all costs billed by Owner. If an item cannot be corrected within thirty (30) calendar days, the reasons therefore shall be explained, in writing, to Owner’s satisfaction. It is agreed that the preparation of a punch list by the parties shall in no way waive or alter any other rights of Owner under the contract, including warranties or latent defects.

(k) Notwithstanding any terms of this Contract to the contrary, if Contractor fails to comply with any of the requirements set forth above for the final progress payment, Owner may, at its election, retain the remainder of the Contract Sum or an amount sufficient to protect Owner against any potential or actual outstanding mechanic's or materialmen's lien rights until all requirements for the final progress payment have been satisfied. If all requirements for the final progress payment have been satisfied, Owner shall release the retainage withheld, less the amount Owner may withhold for setoffs or adjustments under the Contract. In addition Owner may withhold payments otherwise due hereunder to such extent as may be necessary in Owner’s good faith business judgment to protect Owner and Owner from loss because of:

- (i) Defective Work not remedied;
- (ii) Contractor’ breach of any terms or conditions of this Contract;
- (iii) Third party claims relating to Contractor's performance of the Work filed or reasonable evidence indicating the probable filing of such claims, including, but not limited to mechanic’s lien claims;
- (iv) Failure of Contractor to make proper payments to contractors or subcontractors or for labor, materials, supplies or equipment;
- (v) Evidence satisfactory to Owner that the Work cannot be completed for the unpaid balance of the Contract Sum;
- (vi) Damage to Owner’s property or that of a third party;

(vii) Reasonable evidence that the Work will not be completed within the Contract Time;

(viii) Failure of Contractor to carry out the Work in accordance with this Contract.

When the above grounds for withholding payment are removed to Owner's satisfaction, payment shall be promptly made for amounts withheld by reason thereof. If the Contractor fails to perform its obligations under the Contract and becomes obligated to pay Owner a sum of money which exceeds the amount of money retained by Owner under the terms of this Contract, Notwithstanding any terms contained in this Contract to the contrary, in addition to all remedies available at law or in equity, Owner may, at its option, withhold or deduct the amount of money due from the Contractor under this Contract from the monies Owner may be obligated to pay to the Contractor under any other contract between Owner and Contractor.

(l) Any undisputed payment not made by Owner within thirty (30) days of the date when due shall bear interest at the rate of 10% per annum.

8. INDEPENDENT CONTRACTOR / SAFETY / CLEANUP.

(a) Contractor is an independent contractor for the performance of all Work undertaken under this Contract and for the accomplishment of the desired result and Owner shall have no control over the method and means of completing the Work, except that the Contractor shall observe all safety rules and regulations established by Owner, shall exercise due care and diligence to protect the Work and to prevent any injury to or death of any person or damage to property. The Contractor shall at all times enforce strict discipline and good order among its employees, and shall not employ on the job any unfit person or anyone not skilled in the work assigned to him.

(b) The Contractor shall execute and deliver to Owner forms provided by Owner covering the Contractor's Health and Safety Regulations applicable to business operations, the terms and provisions of which are incorporated herein by reference.

(c) The Contractor shall at all times keep the premises free from accumulation of waste materials caused by its operation. Final clean up shall include cleaning of all glass surfaces. The Contractor shall leave the Work "mopped clean" including pressure washing all exterior site surfaces. Cost for this clean up should be included in the Contract Sum. If the Contractor fails to clean up, the Owner may do so and charge the cost to the Contractor.

9. SUBCONTRACTORS.

(a) Nothing contained in this Contract shall create any contractual relation between any subcontractor and the Owner. There shall be no obligation on the part of Owner to pay any sums due any subcontractor.

(b) Contractor shall pay each subcontractor, upon receipt of payment from Owner, an amount equal to the percentage of completion allowed to the Contractor on account of each subcontractor's work.

(c) Contractor agrees that it is as fully responsible to the Owner for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by them as it is for the acts and omissions of persons directly employed by it.

(d) Contractor will require each subcontractor or supplier, to the extent of the Work to be performed by such subcontractor or supplier to (A) be bound to the Contractor by the terms of this Contract, (B) assume toward the Contractor all the obligations and responsibilities that the Contractor assumes toward Owner, and (C) designate Owner as the third party beneficiary of any subcontract.

10. USE OF PREMISES.

The Contractor shall confine its apparatus, storage of materials, and the operation of its workmen to the limits indicated by law, ordinances, permits or direction of Owner and shall not unreasonably permit or allow materials or equipment to accumulate on the premises. The Contractor shall permit and facilitate the inspection of the Work by Owner at any time and it is agreed that Owner may from time to time furnish additional instruction or drawings necessary for the proper execution of the Work.

11. COMPLIANCE WITH LAWS.

The Work shall be in accordance with the best practice of high quality, first class contractors, in compliance with the Plans and Specifications and all applicable codes, rules, regulations, ordinances, law and statutes of local, County, State and Federal authorities, including without limitation, the Federal Social Security Act, the State and Federal Unemployment Insurance Acts, the state workmen's compensation laws, the Wage and Hour Laws, and applicable tax and license laws and regulations of every kind and description, the Occupational Safety and Health Act, including, but not limited to, the Americans with Disabilities Act ("ADA") and Americans with Disabilities Act Guidelines ("ADAAG"), collectively ("Legal Requirements") and without use of asbestos, asbestos-containing materials, or other hazardous materials as defined from time to time by applicable federal or state laws, rules, and regulations. Contractor shall be responsible for becoming familiar with these laws (by consulting such professionals as Contractor deems necessary or appropriate), including any changes thereof, and any associated costs are Contractor's responsibility. Contractor assumes exclusive liability for the reporting and payment of any on all contributions, fees and taxes required under any Legal Requirements, and to the fullest extent allowed by law shall indemnify, defend and hold Owner harmless for any damages or penalties Owner may incur as a result of the failure of the Contractor to comply with such Legal Requirements.

If Contractor knows or should know that the drawings and specifications are at variance with each other or any Legal Requirement, including without limitation any ADA or ADAAG

violation or any state or local accessibility requirement that may supercede ADAAG, Contractor shall notify Agent in writing before Work is performed. The adjustment of the Contract Sum due to necessary changes shall be adjusted before proceeding with the Work. If any of the Work is done contrary to any law without such notice, Contractor shall bear all costs required to correct such Work.

12. CHANGES IN THE WORK.

Owner shall have authority to make minor changes in the Work not involving extra cost, but otherwise, except in an emergency endangering life or property, no extra Work or change in the Work shall be made without written order, signed by Owner and accepted by the Contractor. All such changes shall be authorized by a Field Work Order issued by Owner's representative in the field. The Contractor shall do no Work not expressly provided for under this Contract unless and until he receives a signed Field Work Order authorizing such Work. Subsequently, a Change Order shall be submitted and executed in duplicate by the Contractor (on AIA Form G722) and shall be accompanied by a copy of the Field Work Order authorizing that Work. All Change Orders will be paid by Owner upon final completion of the Work and receipt of an invoice from the Contractor. The Contractor shall submit any and all Change Orders no later than thirty (30) days after store opening. Owner will not pay Change Orders received after this date without prior written notification by the Contractor and written consent by Owner.

13. INDEMNIFICATION.

To the fullest extent allowed by law, the Contractor agrees to protect, indemnify, hold harmless and defend Owner and its parent, subsidiaries and related companies, and the officers, directors, employees, workmen, servants and invitees (the "Owner Group"), from and against all losses, damages, demands, claims, suits and other liabilities, including reasonable attorney's fees and other expenses of litigation, because of (i) bodily injury, including death at any time resulting therefrom, and property damage, including loss of use thereof and downtime, directly or indirectly arising out of or relating to the performance or non-performance of the Work by the Contractor and its subcontractors, and their respective employees, workmen, agents, servants, subcontractors and vendors (the "Contractor Group") or the Contractor Group being present on Owner's premises, excepting only bodily injury or property damage caused by the negligence or willful misconduct of Owner; (ii) the Contractor Group's violation of or failure to comply with any applicable law, regulation, rule or order; and (iii) the Contractor Group's infringement of patent, trade secret or proprietary rights of any third party by any device, process or material, unless the same was specified by Owner. The Contractor's agreement to protect, indemnify, hold harmless and defend as set forth in the immediately preceding sentence shall not be negated or reduced by virtue of the Contractor's insurance carrier's denial of insurance coverage for the occurrence or event which is the subject matter of the claim and/or refusal to defend the Contractor Group or Owner Group.

14. INSURANCE.

Without limiting, negating or reducing the Contractor's undertaking to protect, indemnify, hold harmless, reimburse and defend Owner and other parties as provided in Paragraph 13 hereof, and as part of the consideration for sums paid the Contractor by Owner hereunder, the Contractor

shall at its own cost and expense procure and keep in force and effect the insurance listed below with insurance carrier(s) with a Best Insurance Reports rating of "A" or better and a financial size category of "VIII" or higher and otherwise acceptable to Owner. Before commencing any Work, the Contractor shall furnish Owner with Certificates of Insurance on Owner's forms (or a form otherwise acceptable to Owner) attested by a duly authorized representative of the insurance carrier(s) evidencing that the insurance required hereunder is in force and effect, that such insurance provides the names Owner or any other party specified by Owner, as an additional insured as its interest may appear with a waiver of subrogation, and that the insurance will not be canceled or materially changed without giving to Owner at least thirty (30) days prior written notice (by endorsement if required). In the event the Contractor fails to furnish Owner with acceptable certificates of insurance before the time named in this Contract for commencing Work, Owner shall have the right, but not the obligation, to terminate this Contract.

(a) **Worker's Compensation and Employer's Liability Insurance.** Contractor and all subcontractors retained by or through the Contractor, and all their employees, workmen, agents, and servants shall comply with all requirements of the worker's or workmen's compensations laws of the state or states or other governmental authority in which the Contractor or any subcontractor retained by or through the Contractor is performing any Work hereunder. In addition, the Contractor shall carry Employer's Liability Insurance covering all operations and Work hereunder in an amount not less than \$500,000 per occurrence. All such Worker's Compensation and Employer's Liability Insurance shall expressly provide that all rights of subrogation against Owner are waived.

(b) **General Liability Insurance and Automobile Insurance** (occurrence form): (1) Commercial General Liability Insurance, including Blanket Contractual Liability, Products and Completed Operations Liability and Broad Form Property Damage, covering all Work hereunder, with limits of not less than \$1,000,000 for all liability arising out of injury to or death of one or more persons, in any occurrence/\$2,000,000 aggregate, and \$1,000,000 for all liability arising out of damage to or destruction of property, including loss of use thereof and downtime, in any one occurrence/\$2,000,000 aggregate; (2) Automobile Liability Insurance on all motor vehicles owned, hired, or non-owned, which may be used or connected with any of the Work hereunder, with limits of not less than \$1,000,000 for all liability arising out of damage to or destruction of property, including loss of use thereof and downtime, in any one occurrence/\$2,000,000 aggregate. The policy or policies providing for such insurance shall be endorsed to specifically include the liability assumed by the Contractor under this Contract in Paragraph 13 above in the amounts shown in this Paragraph 14. In addition, such insurance shall specifically name Owner as an additional insured party and shall be primary to any and all other insurance of Owner with respect to any and all claims and demands which may be made against Owner for bodily injury or death resulting therefrom, including injury to or death to the Contractor and its employees, workmen, agents and servants and for property damage, including damage to the Contractor's property, caused by, or alleged to have been caused by, any act, omission or default, negligent or otherwise, of Owner by reason of operations or work hereunder. Such insurance shall specifically provide that it applies separately to each insured against which claim is made or suit is brought, except with respect to the limits of the insurer's liability, and that rights of subrogation against Owner are waived.

- (c) Contractor shall maintain a Completed Value Form, All-Risk, Builder's Risk Insurance Policy, that shall insure all Real Property. "Real Property" is defined as the building structure or any part of the build, structure, materials or Owner's equipment that has been received on the site, including, but not limited to foundations, walls, roofs, all building mechanical equipment, building attachments, fixtures and machinery belonging to and constituting a permanent part thereof.
- (d) Neither the Owner, its agents nor their respective employees will be responsible for any loss or damage caused to the equipment or materials of the Contractor or to any property or articles belonging to the Contractor or its employees or subcontractors, and Contractor waives subrogation against Owner, its agents and their employees.
- (e) The above insurance requirements are minimum requirements and shall not limit the Contractor's liability to Owner in any manner.
- (f) In addition to the above, the Contractor will also satisfy any insurance requirements required by any governmental authority.
- (g) Without limiting the respective obligations of Contractor and its insurer(s) for the performance or nonperformance of each and every subcontractor and supplier participating in the Work, Contractor will cause all subcontractors performing any portion of the Work to comply in each and every respect with the insuring obligations applicable to Contractor under this Article 14 (other than subsection (c)), including providing to Owner properly prepared certificates of insurance, and copies of additional insured and waiver of subrogation endorsements, before commencing any Work, and again prior to the expiration of any required insurance coverage.

15. SURETY BONDS.

Unless specifically waived by Owner, the Contractor shall furnish surety bonds in the amount of the Contract Sum by a company acceptable to Owner covering the faithful performance of all the Contractor's obligations hereunder, including, but not limited to, payment of all sums which become due hereunder, and which satisfies such bond or performance guaranty requirements as may be imposed by a governmental authority for the faithful performance of the contract and satisfaction of all conditions, requirements, laws and regulations imposed by governmental authority, including any legal fees, interest, increased costs and expenses Owner may incur to enforce or complete the contract, in accordance with the Plans and Specifications, and it will provide that the work at all times be free and clear of all liens of workmen, material suppliers, subcontractors, or due to any activity of Contractor. The bond shall name Owner as obligee and the Contractor shall not begin the Work until such bond is furnished to Owner.

16. TERMINATION FOR CAUSE.

Notwithstanding anything herein to the contrary, if

- (a) relief has been ordered under the Bankruptcy Code with respect to the Contractor, or if the Contractor should make a general assignment for the benefit of its creditors, or if a trustee, receiver, custodian or similar officer should be appointed on account of its insolvency, or
- (b) should the Contractor fail, neglect or refuse to perform any or all work, or
- (c) if a lien has been placed upon or against the work or the real property upon which the Work is situated, or
- (d) the Contractor assigns any monies due or to become due hereunder without the previous written consent of Owner, or
- (e) if at any time Owner believes, in its discretion, that the Work is unreasonably delayed for any reason or any of the provisions of this Contract are being willfully violated or executed carelessly, or that the Contractor is acting in bad faith; or
- (f) if the Work is partially or totally delayed by any labor dispute between the Contractor and its employees or between the Contractor and its employees and any other contractor or subcontractor and their respective employees or any work stoppage or slowdown by the Contractor's employees or any subcontractor or its employees for a period of ten (10) calendar days;

then Owner may notify the Contractor in writing and request that it immediately remedy the deficiency or delay. If the Contractor has not remedied or commenced action which promptly will remedy the same within forty-eight (48) hours of notice being delivered, then Owner may without prejudice to any other right or remedy terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances thereon and finish the Work by whatever method Owner may deem expedient. In such case, the Contractor shall not be entitled to receive any further payments until the Work is finished and releases or waivers of all liens have been obtained or the applicable statutory time for filing a lien has passed. If the unpaid balance of the Contract Sum shall exceed the expenses of finishing the Work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expenses shall exceed such unpaid balances, the Contractor shall pay the difference to Owner within ten (10) days of written demand.

17. TERMINATION FOR CONVENIENCE.

Notwithstanding anything herein to the contrary for its convenience, Owner may, without prejudice to any other right or remedy, terminate the engagement of the Contractor in whole or in part at any time by written notice or telephonic notice (confirmed in writing) to the Contractor which notice shall state the extent and effective date of the termination. Upon the giving of such notice, Owner may take possession of the premises and of all materials, tools, and appliances thereon belonging to Owner and finish the Work by whatever method Owner may deem expedient. On the effective date thereof, the Contractor shall (a) stop all Work and place no further orders or subcontracts, (b) terminate work orders and subcontractors outstanding, and (c) take any necessary

action to protect property in the Contractor's possession in which Owner has or may acquire an interest. In the event of a termination under this section, Owner shall pay the Contractor for any and all labor, materials and supervision performed to date of termination, but shall not pay any other costs or expenses on Work not performed.

18. SUSPENSION.

(a) Notwithstanding anything herein to the contrary and for causes including, but not limited to, those set forth in Paragraph 16 above or for Owner's convenience, Owner may suspend labor, supervision and/or materials furnished by the Contractor hereunder in whole or in part at any time by written notice or telephonic notice (confirmed in writing) to the Contractor stating the extent and effective date of such suspension whereupon the Contractor shall suspend the Work to the extent specified. If the suspension is for causes including, but not limited to, the existence of a condition described in Paragraph 16 hereof, such suspension shall continue until such cause or condition ceases to exist or Owner notifies the Contractor to resume performance under this Contract or Owner terminates this Contract in accordance with Paragraph 17 hereof, whichever is the earliest to occur. If suspension is for the convenience of Owner and suspension for such cause continues for thirty (30) consecutive working days, the Contractor shall have the right to terminate this Contract in whole or in part by written notice or telephonic notice (confirmed in writing) to Owner which notice shall state the extent and effective date of the termination. In such event this Contract shall terminate in accordance with the Provisions of Paragraph 17 hereof.

(b) During the period of suspension, the Contractor shall protect and care for all labor, materials and equipment on hand. If the cost of the labor, supervision and materials to be provided hereunder, made necessary by the suspension, is increased or decreased by the suspension, the Contract Sum will be adjusted as follows: Within five (5) working days after receipt of a written notice of suspension, the Contractor shall give Owner an estimate of the increase or decrease in the cost of the Work resulting from such change, if any, necessary to reasonably compensate the Contractor for such change. If Owner agrees that the estimate is reasonable, Owner shall issue an amendment to this Contract providing for such change in the Contract Sum. If Owner disagrees with the reasonableness of the estimate, it shall give the Contractor written notice of such disagreement within five (5) working days of receipt of the estimate. Owner shall have the right to terminate this Contract in accordance with Paragraph 17 hereof or to negotiate with the Contractor in an attempt to reach agreement as to the amount of such increase or decrease in the cost of such labor, supervision and materials. If Owner and the Contractor cannot mutually agree on such amount within ten (10) working days from the date of Owner's notice of disagreement with the Contractor's original estimate, either party shall have the right to terminate this Contract in whole or in part by written notice to the other party which notice shall state the extent and effective date of the termination. In such event this Contract shall terminate in accordance with the provisions of Paragraph 17 hereof.

19. COOPERATION WITH OTHER CONTRACTORS AND OWNER.

Owner reserves the right to let other contracts in connection with the Work or work related thereto and it is agreed that the Contractor shall cooperate with all other contractors and shall properly coordinate the Work with theirs. The Contractor shall cooperate fully with Owner in performing the Work and shall not interfere with Owner's operations.

20. FORCE MAJEURE.

If the Contractor shall be delayed at any time in the progress of the Work due to an act or negligence of Owner or any other contractor employed by Owner or by changes in the Work, fire, or other cause beyond the Contractor's control, then the Contract Time shall be extended for such reasonable time as Owner may decide. Claims for extension of time shall be made in writing at the time the delay first occurs, in any event no later than seven (7) days after the delay occurs. The Owner shall not be held responsible for loss or damage sustained by the Contractor through delay caused by any other contractor, or by abnormal weather conditions, or any other cause beyond the control of the Owner. It is expressly understood and agreed that Contractor's sole remedy for any such delay shall be an increase in the Contract Time, without adjustment to the Contract Sum.

21. CONFLICTING PROVISIONS, AMENDMENTS.

The terms, provisions, covenants, or conditions herein contained shall control in the event of any conflict with any provision, term, covenant or condition in any of the documents attached hereto and made a part hereof, or any work orders, purchase orders, requisitions, or any other forms or documents. This Contract represents the entire and integrated agreement between the parties hereto and supersedes all prior negotiations, representations, or agreements, either written or oral. It is expressly understood and agreed that all additions to, changes in and amendments to this Contract must be in writing and signed by both parties.

22. REPRESENTATIONS.

The Contractor represents to and covenants with Owner that the Contractor is duly licensed and qualified to do business in the state or states in which the Work is to be performed.

23. EQUAL EMPLOYMENT OPPORTUNITY.

The Contractor shall execute and deliver to Owner forms provided by Owner covering certain Equal Employment Opportunity Provisions and Certification of Nonsegregated Facilities applicable to the Contractor's business and operations, the terms and provisions of each of which are incorporated herein by reference.

24. RECORDS.

The Contractor shall keep all records required by any law or regulation and all other records requested by Owner. Owner shall have the right at any time, upon reasonable notice, to inspect the Contractor's books and records either in the field or at the Contractor's home office to the extent necessary to verify that the Contractor's labor costs and any other costs or expenses as set forth on the monthly statements have been calculated in accordance with this Contract. The Contractor

agrees that such books and records shall be maintained for a period of at least three (3) years from the completion date of the Work

25. NOTICES.

All notices required under this Contract shall be in writing and if to Owner, shall be sufficient in all respects if delivered in person or sent by registered or certified mail to:

VALVOLINE INSTANT OIL CHANGE,
a business of VALVOLINE LLC
100 VALVOLINE WAY
LEXINGTON, KY 40509
ATTN: CONSTRUCTION MANAGER

and if to the Contractor shall be sufficient in all respects if delivered in person or sent by registered or certified mail to:

26. ASSIGNMENT.

The Contractor shall not assign this Contract or subcontract the Work as a whole without the prior written consent of Owner nor shall the Contractor assign any monies due or to become due hereunder without the previous written consent of Owner. Owner shall have the right to assign all of its rights and to delegate all of its duties and obligations under this Contract at any time during the term of the Contract. Owner shall notify Contractor of the name and address of any assignee. Subject to the provisions of this Section 26, this Contract is binding upon and shall inure to the benefit of Owner and Contractor and their respective successors and assigns.

27. AMENDMENTS.

No amendment, alteration, modification or waiver of this Contract shall be valid or enforceable unless in writing and duly executed by authorized officers or attorneys-in-fact of the parties sought to be charged. It is agreed that this Contract shall not be deemed amended, altered or modified by the term of any sales order used by the Contractor or invoice rendered or delivered hereunder and Owner shall not be bound by the terms and provisions of any such sales order or invoice.

28. NON-WAIVER / CUMULATIVE REMEDIES.

No failure or delay on the part of Owner in exercising any right, power or privilege hereunder and no course of dealing between the Contractor and Owner shall operate as a waiver thereof; nor shall any single or partial exercise of any right, power or privilege hereunder preclude

any other or further exercise thereof or the exercise of any other right, power or privilege. The rights and remedies herein expressly provided are cumulative and not exclusive of any rights or remedies which Owner would otherwise have. No notice to or demand on the Contractor in any case shall entitle the contractor to any other or further notice or demand in similar or other circumstances or constitute a waiver of the right of Owner to any other or further action in any circumstances without notice or demand.

29. SEVERABILITY OF PROVISIONS.

If any part of this Contract, or the application of any such provision to any person or in any circumstance is held invalid, the application of such part to any other person or in any other circumstance or other jurisdictions, and the remainder of this Contract, shall not be affected thereby and shall remain in full effect.

30. USE OF MARKS AND NAMES.

Contractor shall not, without the prior written consent of Valvoline, (i) use the tradename, service marks, trademarks or trade dress of Valvoline or of any of its affiliated companies for any purposes, including but not limited to in any advertising, publicity release or sales representation; (ii) reveal the existence of this Contract or the terms or conditions hereof to any person or entity; and (iii) include Valvoline's name in any list of representative clients without Valvoline's express written consent

31. HEADINGS.

Paragraph headings in this Contract are included herein for convenience of reference only and shall not constitute a part of this Contract for any other purpose.

32. NO DISCRIMINATION.

Contractor agrees that in connection with the performance of its obligations under this Agreement, it will not discriminate against any person on the basis of race, gender, age, national origin or any other improper or illegal distinction. Contractor shall fully comply with all laws, codes, ordinances and regulations relating to the employment of minorities and women as employees, contractors and vendors.

33. GOVERNING LAW.

This Contract shall be governed and constructed in accordance with the laws of the state where the Project is located.

IN TESTIMONY WHEREOF, witness the signatures of the Parties hereto the day and year first above written.

CONTRACTOR:

Witness as to Contractor

By: _____

Witness as to Contractor

Title: _____

OWNER:

VALVOLINE INSTANT OIL CHANGE,
a business of VALVOLINE LLC

Witness as to Owner

By: _____

Witness as to Owner

Title: _____

EXHIBIT A
PLANS AND SPECIFICATIONS
(SEE ATTACHED)

EXHIBIT B
PROJECT SCHEDULE
(SEE ATTACHED)

EXHIBIT C
CONTRACT SUM
(SEE ATTACHED)

CONTRACTORS WORK ADDENDUM

This Addendum is attached and forms a part of the Construction Contract dated _____, 20____ ("Contract") between _____ ("Contractor") and **Valvoline Instant Oil Change, a business of Valvoline, LLC.** ("Agent"). Contractor and Agent agree as follows:

1. Contractor promises to perform the following work ("Contractor's Work"):

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

2. The following described drawings, plans and specifications related to the Contractors Work identified below have been delivered to the Contractor and have been cosigned by the parties on _____ 20____. Receipt of a copy of the specifications is hereby acknowledged and the plot plans, plans and specifications are incorporated into and made a part of this Contract. Revisions to the plans and specifications made subsequent to the execution of this Contract, if any, shall be co-signed by the parties and become a part of this Contract.

3. If Agent has retained the services of a Construction Manager for the project. The Construction Managers name and address is as follows:

Contractor's Initials

Agent's Initials

**CONTRACTOR'S
CERTIFICATE OF COMPLIANCE**

Instructions: Contractor shall complete and submit this certification to Valvoline upon completion.

Contractor: _____

Project: Construction site common address of: _____

Store Number: _____

I, _____ ("Contractor's Representative"), with express authorization of
_____ ("Contractor"), certify as follows:

1. On _____, 20__, Contractor and Valvoline entered into a Construction Contract dated
_____, (collectively referred to as the "Contract") by and between Valvoline, LLC. through its
Division Valvoline Instant Oil Change as agent ("Agent"), and Contractor.

2. The Contract requires that Contractor certify that all Work was performed in compliance with
the Contract Documents, that to the best of its knowledge, information and belief no Defective Work
exists, and that it has performed all of its duties under the Contract in accordance with all Legal
Requirements.

3. On _____, 20__, construction of the Project was substantially complete in accordance
with the terms of the Contract.

4. I certify that Contractor has reviewed and analyzed all Contract Documents.

5. I certify that Contractor has performed all of its obligations and duties under the Contract in
accordance with the Contract Documents and that to the best of its knowledge, information and
belief no Defective Work exists.

6. I certify that to the best of my knowledge, information and belief that construction of the Project
was performed in conformance with the construction documents, the final working plans and
specifications and that no Defective Work exists.

7. I further certify that to the best of my knowledge information and belief the Project, as constructed,
is not in violation of any Contract Documents.

I represent the above certifications are true and correct to the best of my knowledge, information and
belief.

Contractor: _____

Certified and
Signed by: _____

Name: _____

Title: _____

Date: _____

Signed and Sealed this _____ day of
_____, 20__.

Notary Public

VALVOLINE INSTANT OIL CHANGE
100 Valvoline Way – Lexington, KY 40509
CONTRACT FOR LABOR, SUPERVISION AND MATERIALS

Company Name:
Address:
City, State, Zip
United States

This Agreement shall be effective for the term beginning: _____, and shall continue for a period of two (2) years (the "Initial Term") unless sooner terminated as provided herein. Thereafter, this Agreement shall automatically renew for successive one (1) year periods (the "Renewal Term") unless either party gives the other party at least ninety (90) days prior written notice of termination prior to the expiration of the Initial Term or any Renewal Term. This Agreement is intended to eliminate the necessity of preparing individual contracts on future occasions that we might wish to arrange with you to furnish labor, materials, and supervision, or any of them, to Valvoline LLC., its subsidiaries and affiliates ("OWNER"). Any purchase order of OWNER, specifications, plans or schedules approved in writing by OWNER and CONTRACTOR shall be considered part of the Agreement.

1. SCOPE OF WORK

Subject to the terms and conditions of this Agreement, CONTRACTOR undertakes to provide OWNER with the work or services described in any purchase orders which may be issued by OWNER and accepted by CONTRACTOR from time to time during the term of this Agreement (the "Work").

2. TERM

Work shall be started and shall be substantially completed on the dates specified in any applicable schedule delivered by OWNER to CONTRACTOR. Notwithstanding anything above to the contrary, unless CONTRACTOR is otherwise advised by OWNER in writing, the term of this Agreement shall be extended until completion of any work or services in progress.

3. COMPENSATION

- (a) It is agreed that any Work to be furnished during the term of this Agreement shall be furnished for the following lump sum amount or at the rates set forth on Exhibit A attached hereto.
- (b) No overtime work or premium rates will be paid or authorized by CONTRACTOR unless OWNER has expressly approved such payment in writing; provided that persons expressly designated in writing by OWNER for such purpose may give oral approval to spot overtime work.
- (c) In the event of time and material work, CONTRACTOR must give thirty (30) days advance written notice if it changes rates. No rate change or cost change will be effective until accepted by OWNER in writing. Such change will not apply to any Work in progress at time of notice without OWNER'S written consent.

4. PAYMENT

- (a) For lump sum work, CONTRACTOR shall have the right to request that the OWNER make partial payments; provided, however, that OWNER shall have the right to withhold up to and including _____% of the amount of any invoice submitted to OWNER by CONTRACTOR for labor, supervision and materials furnished by the CONTRACTOR up to the time of completion and, if applicable, _____% of the total contract price set forth above. Payment of said retainage shall be due upon OWNER'S acceptance of all work.
- (b) Each invoice must, in addition to total charges, show separately on its face the labor costs or equipment costs, as applicable, material costs, and any applicable freight charges and sales and use taxes. For reimbursable work, time sheets, equipment logs, material tickets, or similar supporting documentation must be signed by OWNER'S representative. This substantiation or any other evidence the OWNER may require shall be attached to the invoice. In addition, any applicable markups such as fringe benefits, unemployment taxes, workers compensation insurance, payroll taxes, overhead and profit, etc. must be itemized.
- (c) Subject to Paragraph (b) above, OWNER shall pay CONTRACTOR's invoice in accordance with OWNER's payment terms.

5. CHANGES IN THE WORK

OWNER may require CONTRACTOR to make minor changes in the Work which do not involve extra cost. Otherwise, no changes (except emergency work necessary to protect life or property) shall be made without a written change order which shall include OWNER's agreement to any extra charges.

CONTRACTOR shall permit and facilitate the inspection of the work by OWNER at any time and it is agreed that OWNER's engineer may from time to time furnish additional instructions or drawings necessary for the proper execution of this Work.

6. SURETY BONDS

Unless specifically waived by OWNER in writing, CONTRACTOR at its own expense shall furnish a surety bond in the amount of the contract price in a company acceptable to OWNER covering the faithful performance of all of CONTRACTOR's obligations hereunder, including, but not limited to, payment of all sums which become due hereunder, and CONTRACTOR shall not begin any work required hereunder until such bond is furnished to OWNER.

7. WARRANTY

- (a) CONTRACTOR represents and warrants that it is experienced in the Work to be undertaken on behalf of OWNER and possesses the skills to complete the Work.
- (b) The Work shall be performed in a good and workmanlike manner by qualified, careful and efficient workers in accordance with the Agreement, in strict conformity with the best standard practices and in a manner protective of its employees, the public and the environment. CONTRACTOR further guarantees all Work to be performed against defects resulting from poor workmanship or materials furnished by CONTRACTOR for a period of one (1) year from the date

the Work is completed and accepted by OWNER. In the event any Work proves unsatisfactory within the period specified above, without waiving any other rights or remedies OWNER may have at law, CONTRACTOR covenants and agrees to make good such defects and any damage to other work or material caused by the defects or by the repairing of such defects at CONTRACTOR's expense without cost to OWNER.

8. PERMITS, LICENSES AND FEES

Unless in its notification of work OWNER agrees to the contrary, CONTRACTOR shall secure all permits and licenses necessary for the accomplishment of the WORK to be done hereunder and shall comply with all local laws and regulations and, if anything herein contained is at variance with any law or regulation, then the CONTRACTOR shall notify the OWNER's engineer and receive written instructions before proceeding with the Work.

9. WORK TO BE PERFORMED BY OWNER

- (a) OWNER shall furnish CONTRACTOR with a description and scope of each project where appropriate, furnish drawings, specifications, changes and field engineering. OWNER will have the right, at any time and from time to time, to submit revised drawings and specifications.
- (b) OWNER's obligations hereunder to CONTRACTOR shall be strictly limited to the payment for labor, materials, and supervision actually furnished by CONTRACTOR under the terms of this Agreement.

10. COOPERATION WITH OTHER CONTRACTORS AND OWNER

The OWNER reserves the right to let other contracts in connection with this Work or work related thereto and CONTRACTOR shall cooperate with all other contractors and shall properly coordinate its Work with theirs. CONTRACTOR shall cooperate fully with OWNER in performing the Work to be done hereunder and shall not interfere with OWNER's operations.

11. LIENS

- (a) In consideration of the contract price to be paid CONTRACTOR hereunder, CONTRACTOR hereby waives any claim to a lien against the property of OWNER which it now has or which may hereafter arise out of, or during the performance of, this Agreement. CONTRACTOR shall make reasonable efforts to obtain a similar waiver of lien from any subcontractor, materialmen or others providing work or service hereunder and shall immediately advise OWNER in writing in the event any such persons refuse to furnish a waiver of lien.
- (b) Upon notification by OWNER, or upon CONTRACTOR's independently learning of a lien or threatened lien or right of any kind which has been placed upon or against the Work of the real property upon which the Work is situated, by CONTRACTOR's laborers, materialmen, subcontractors or other creditors, CONTRACTOR shall immediately:
 - (1) Pay and discharge the underlying obligations or alleged obligations of the claimed lien; or
 - (2) (i) provide security sufficient and satisfactory to OWNER, or

- (ii) obtain a waiver of lien from such parties as may be satisfactory to OWNER,

CONTRACTOR's failure to comply with the provision of this Paragraph 11(b) within five (5) days of the date CONTRACTOR learns or should have learned of the claimed liens shall constitute a material default hereunder and shall entitle OWNER to pay and discharge all such liens or alleged liens and deduct all such payments from any amounts due CONTRACTOR hereunder whether or not such liens are valid, and shall further entitle OWNER to such remedies as are provided herein or by law.

- (c) Before making any payment hereunder, OWNER may require that CONTRACTOR furnish a full and complete waiver or release of liens from each subcontractor, materialman, artisan, or mechanic retained by CONTRACTOR waiving or releasing any liens or claims whatever against the Work to be performed herein.

12. TERMINATION

- (a) Notwithstanding anything herein to the contrary and for causes including but not limited to those set forth in Paragraph 19 below or for its convenience, OWNER may without prejudice to any other right or remedy terminate the employment of CONTRACTOR in whole or in part at any time by written or telegraphic notice to CONTRACTOR which notice shall state the extent and effective date of the termination. Upon the giving of such notice OWNER may take possession of the premises and of all materials, tools and appliances thereon belonging to OWNER and finish the Work by whatever method OWNER may deem expedient or elect not to complete the Work. On the effective date thereof, CONTRACTOR shall (a) stop all Work and place no further orders or subcontracts, (b) terminate work orders and subcontractors outstanding, and (c) take any necessary action to protect property in CONTRACTOR's possession in which OWNER has or may acquire an interest. In the event of a termination under this paragraph, OWNER shall pay CONTRACTOR for any and all labor, materials and supervision performed to date of termination.
- (b) Notwithstanding anything herein to the contrary, if relief has been ordered under the Bankruptcy Code with respect to CONTRACTOR, or if CONTRACTOR should make a general assignment for the benefit of its creditors, or if a trustee, receiver, custodian or similar officer should be appointed on account of insolvency, or should CONTRACTOR fail, neglect or refuse to perform any or all Work, or if a lien has been placed upon or against the Work or the real Property upon which the Work is situated and is not discharged or satisfied as provided in Paragraph 11 above, or CONTRACTOR assigns any monies due or to become due hereunder without the previous written consent of OWNER, or at any time OWNER believes, in its discretion, that the work is unreasonably delayed for any reason or any of the provisions of this Agreement are being willfully violated or executed carelessly, or that CONTRACTOR is acting in bad faith, or if the Work is partially or totally delayed by any labor dispute between CONTRACTOR and its employees or between CONTRACTOR and its employees and any other contractor and its employees or any Work stoppage or slowdown by CONTRACTOR's employees for a period of ten (10) calendar

days, then OWNER or its representatives may notify CONTRACTOR in writing and request that it immediately remedy the deficiency or delay; and, if the same shall not be remedied within twenty-four (24) hours of notice being delivered, then OWNER may without prejudice to any other right or remedy terminate the employment of CONTRACTOR and take possession of the premises and of all materials, tools and appliances thereon and finish the Work by whatever method OWNER may deem expedient. In such case, CONTRACTOR shall not be entitled to receive any further payments until the Work is finished and releases or waivers of all liens have been obtained, or the applicable statutory time for filing a lien has passed. If the unpaid balance of the contract price shall exceed the expenses of finishing the Work, including compensation for additional managerial and administrative services, such excess shall be paid to CONTRACTOR. If such expenses shall exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. If it is determined, however, that CONTRACTOR's failure to perform is not due to the breach, fault or negligence of CONTRACTOR (other than insolvency or an act of bankruptcy) such cancellation shall be deemed to have been made pursuant to Paragraph 12(a) hereof.

13. SUSPENSION

- (a) OWNER may suspend the Work in whole or in part at any time by written or telegraphic notice to CONTRACTOR stating the extent and effective date of such suspension whereupon CONTRACTOR shall suspend the Work to the extent specified. If the suspension is for causes including, but not limited to, the existence of a condition described in Paragraph 19 hereof, such suspension shall continue until such cause or condition ceases to exist or OWNER notifies CONTRACTOR to resume performance under this Agreement or OWNER terminates this Agreement in accordance with Paragraph 12 hereof, whichever is the earliest to occur. If suspension is for the convenience of OWNER and such suspension continues for twenty (20) working days, CONTRACTOR shall have the right to terminate this Agreement in whole or in part by written or telegraphic notice to OWNER which notice shall state the extent and effective date of the termination. In such event this Agreement shall terminate in accordance with the provisions of Paragraph 12 hereof.
- (b) During the period of suspension, CONTRACTOR shall protect and care for the Work on hand. If the cost of the Work, including the cost of additional labor, supervision and materials made necessary by the suspension, is increased or decreased by the suspension, CONTRACTOR shall give OWNER a written estimate of the increase or decrease in the cost of the Work resulting from such change. IF OWNER accepts the estimate, OWNER shall issue a written purchase order per Paragraph 5. If OWNER and CONTRACTOR cannot mutually agree on such amount within ten (10) working days from the date of OWNER's notice of disagreement with CONTRACTOR's original estimate, either party shall have the right to terminate this Agreement in whole or in part by notice to the other party which notice, as provided in Paragraph 23 hereof, shall state the extent and effective date of the termination. In such event this Agreement shall terminate in accordance with the provisions of Paragraph 12 hereof.

14. CONFLICTING PROVISIONS

The terms, provisions, covenants, or conditions herein shall control in the event of any conflict with any provision, term, covenant or condition in any of the documents attached hereto and made a part hereof, or any work orders, purchase orders, requisitions, or any other forms or documents.

15. INDEMNIFICATION

CONTRACTOR agrees to protect, indemnify, hold harmless and defend OWNER, its subsidiaries and related companies, and officers, directors, employees, workmen, agents, servants and invitees of OWNER, its subsidiaries and related companies (collectively, "Indemnitees"), from and against all losses, damages, demands, claims, suits and other liabilities (including attorney fees and other expenses of litigation) relating to or arising out of:

- (i) bodily injury, including death (including without limitation injury to or death of an INDEMNITEE or its employees) at any time resulting therefrom,
- (ii) damages to all property (including without limitation, the property of INDEMNITEES), including loss of use thereof and downtime,
- (iii) contamination of or adverse effects on the environment, including the cost of cleanup,
- (iv) violation of or failure to comply with any applicable law, regulation, rule or order which occur, either directly or indirectly, in connection with performance of the Work or by reason of CONTRACTOR and its employees, workers, agents, servants, subcontractors and vendors being present on OWNER's premises, except to the extent the liability, loss or damage is attributable to and caused by the sole and exclusive negligence of OWNER,
- (v) infringement of patent, trade secret or proprietary rights of any third party by any device, process or material not specified by OWNER, and
- (vi) CONTRACTOR'S presence on OWNER'S premises regardless of whether any liability arises out of or relates to the negligence (active or passive) fault, and/or strict liability of an INDEMNITEE occurring jointly, concurrently and/or comparatively with the negligence, fault, and/or strict liability of CONTRACTOR and/or any other person that is not an INDEMNITEE, other than the sole negligence of such INDEMNITEE.

CONTRACTOR'S agreement to protect, indemnify, hold harmless and defend as set forth in the immediately preceding sentence shall not be negated or reduced because CONTRACTOR'S insurance carrier denies insurance coverage for the claim and/or refusal to defend CONTRACTOR or OWNER. In addition, CONTRACTOR will pay all costs and expenses, including attorney fees and all other expenses of litigation incurred by an INDEMNITEE to enforce the foregoing agreement to protect, indemnify, hold harmless and defend an INDEMNITEE.

16. INSURANCE

Without limiting, negating or reducing CONTRACTOR'S undertaking to protect, indemnify, hold harmless, and defend OWNER and other parties as provided herein, and as part of the consideration for any sums paid CONTRACTOR by OWNER hereunder, CONTRACTOR shall at its own cost and expense procure and keep in force and effect the insurance listed below with insurance carrier(s) acceptable to OWNER. Before commencing to provide any Work, CONTRACTOR shall furnish OWNER with Certificates of Insurance attested by a duly authorized representative of the insurance

carrier(s) evidencing that the insurance required hereunder is in force and effect and that such insurance will not be canceled or materially changed without giving to OWNER at least 30 days prior written notice. If CONTRACTOR fails to provide or maintain any or all of the insurance required hereby or otherwise fails to comply with any of the requirements of this Section, and, in spite of such failure, OWNER allows performance of Work to commence or to continue, CONTRACTOR shall not be released from its obligation to supply such insurance or to comply with such requirements, and shall be liable for any and all damages and losses suffered by OWNER as a consequence of such failure.

(a) Worker's Compensation and Employer's Liability Insurance: CONTRACTOR, all subcontractors retained by or through CONTRACTOR, third party, and all their employees, workmen, agents, and servants shall comply with all requirements of the worker's or workmen's compensation laws of the state or states or other governmental authority in which CONTRACTOR, any subcontractor retained by or through CONTRACTOR, or third party is providing any Work hereunder. In addition, CONTRACTOR shall carry Employer's Liability Insurance covering all Work hereunder in an amount not less than \$500,000 per occurrence. All such Worker's Compensation and Employer's Liability Insurance shall expressly provide that all rights of subrogation, where permitted by law, are waived.

(b) General Liability Insurance and Automobile Liability Insurance (occurrence form):

(1) General Liability Insurance, including Blanket Contractual Liability, Products and Completed Operations Liability, XCU Hazards and Broad Form Property Damage, covering all Work hereunder, with limits of not less than the following:

Commercial General Liability - \$5,000,000 Combined Single Limit for all liability arising out of injury to or death of one or more persons, in any one occurrence, and for all liability arising out of damage to or destruction of property, including loss of use thereof and downtime, in any one occurrence, with a General Annual Aggregate not less than \$5,000,000;

(2) Automobile Liability Insurance on all motor vehicles owned, hired, or non-owned which may be used or connected with delivery of any of the Work hereunder, with limits of not less than \$5,000,000 Combined Single Limit for all liability arising out of injury to or death of one or more persons, in any one occurrence, and for all liability arising out of damage to or destruction of property, including loss of use thereof and downtime, in any one occurrence. If the CONTRACTOR or its subcontractors use automobiles to transport hazardous materials they shall have an MCS-90 endorsement ("Environmental Restoration") included in their Automobile Liability Insurance.

(c) Contractor's Pollution Legal Liability/Environmental Impairment Insurance coverage - \$5,000,000 per occurrence with a Annual Aggregate not less than \$5,000,000.

The policy or policies providing for such insurance shall be endorsed to specifically include the liability assumed by CONTRACTOR under this Agreement. In addition, with the exception of Worker's Compensation and Employer's Liability and Contractor's Pollution Legal Liability/Environmental Impairment Insurance, such insurance shall

specifically name OWNER as an additional insured party, and shall be primary to any and all other insurance of OWNER, with respect to any and all claims and demands which may be made against OWNER for bodily injury or death resulting therefrom, including injury to or death of CONTRACTOR and its employees, workmen, agents and servants, and for property damage, including damage to CONTRACTOR 'S property, caused by, or alleged to have been caused by, any act, omission or default, negligent or otherwise, of OWNER by reason of Work delivered hereunder. All such Worker's Compensation and Employer's Liability Insurance shall expressly provide that all rights of subrogation against OWNER are waived. Such insurance shall specifically provide that it applies separately to each insured against which claim is made or suit is brought, except with respect to the limits of the insurer's liability, and that all rights of subrogation against OWNER are waived.

The above insurance requirements are minimum requirements and shall not limit CONTRACTOR 'S liability to Valvoline in any manner.

17. RECORDS

- (a) CONTRACTOR agrees to retain all records and accounts related to charges or CONTRACTOR invoices for a period of at least three (3) years from the completion date of any Work performed.
- (b) CONTRACTOR shall permit OWNER access to, either in the field or at the home office, for review and audit, at all reasonable times, all records and accounts relating to costs and expenses invoiced to OWNER under this Agreement.

18. INDEPENDENT CONTRACTOR

CONTRACTOR is an independent contractor. OWNER shall exercise no control over the method and means of accomplishing the Work other than to see that the desired results are achieved at the lowest possible cost to OWNER.

19. FORCE MAJEURE

Except for the payment of any sums due, neither party shall be responsible for any failure to fulfill any term of this Agreement, if fulfillment has been delayed, hindered or interfered with or prevented by any circumstances whatsoever, which are not within the control of the party in question and could not have been prevented or overcome by the exercise of due diligence by the party concerned.

20. COMPLIANCE WITH LAWS AND REGULATIONS

- (a) CONTRACTOR agrees to comply with the Federal Social Security Act, the state and Federal Unemployment Insurance Acts, the Americans With Disabilities Act, state workers compensation laws, wage and hour laws, any and all applicable sales, use, and gross receipts tax laws and regulations, applicable safety and health laws, standards and regulations, any applicable environmental laws and regulations, and all other applicable laws, regulations, guidelines, permits, licenses and approvals concerning the Work and CONTRACTOR assumes exclusive liability for the reporting and payment of any and all contributions and taxes required thereby.

- (b) CONTRACTOR shall execute OWNER's Exhibit B covering certain Equal Employment Opportunity Provisions and Certification of Non-segregated Facilities.
- (c) CONTRACTOR shall abide by OWNER's safety and health regulations while performing any Work and shall execute Exhibit C, OWNER's Safety and Health Practices.

21. ASSIGNMENTS AND SUBCONTRACTS

CONTRACTOR shall not assign this Agreement or sublet the Work as a whole or part without the prior written consent of OWNER.

22. GOVERNING LAW

This Agreement shall be construed, and the rights of the parties shall be determined, in accordance with the laws of the State of Ohio.

23. NOTICES

All notices required under this Agreement shall be in writing and if to OWNER, shall be sufficient in all respects if delivered in person or sent by registered or certified mail, return receipt requested, or by telex, telecopy or other facsimile to the addresses above or such other addresses as may be designated from time to time.

24. CONFIDENTIALITY

Any technical information, experience or data concerning Company's business, including without limitation its services, plans, programs, plants, processes, products, costs, equipment, operations or customers, which may come within the knowledge of CONTRACTOR, its officers or employees in the performance of this Agreement shall be treated as confidential property of Company and shall not be used by CONTRACTOR except for the benefit of Company in the furtherance of this Agreement, and shall not be disclosed to others, including governmental agencies or other authorities during or subsequent to the term of this Agreement without in each instance securing the prior written consent of Company. Any such information provided by Company to CONTRACTOR in writing or other tangible media shall be returned to Valvoline upon termination of this Agreement.

25. OWNERSHIP OF WORK PRODUCT

CONTRACTOR hereby agrees to transfer to Company the entire right, title and interest to any copyrights in any work produced by CONTRACTOR under this Agreement. CONTRACTOR further agrees to execute any documents which may be necessary or appropriate to allow Company to perfect its interest in the copyright for such works. CONTRACTOR shall not be entitled to any additional payment or compensation for assisting and cooperating with the Company in obtaining these copyrights.

26. DRAWINGS

All drawings and documents prepared by CONTRACTOR in connection with its performance of the Work are the property of OWNER and are not to be used on other projects except by agreement of OWNER in writing. All such drawings and documents shall be transmitted to OWNER at the completion of the work.

27. ENTIRETY OF AGREEMENT

This Agreement is intended by the parties as the final, complete and exclusive statement of the terms, conditions and specifications of their agreement and is intended to supersede all previous agreements and understandings between the parties relating to its subject matter. No prior stipulation, agreement, understanding or course of dealing between the parties or their agents with respect to the subject matter of this Agreement shall be valid or enforceable unless embodied in this Agreement. No amendment, modification, termination notice or waiver of any provision of this Agreement shall be valid or enforceable unless in writing and signed by the party to be charged. This Agreement shall supersede, and shall not be modified or amended in any way by the printed terms of any purchase order, proposal, quotation or other document which may be issued by either party covering work or services rendered.

28. WAIVER

The failure of any party to insist upon strict performance of any of the terms, conditions and provisions of this Agreement shall not be deemed a waiver of future compliance therewith by the party by which the same is required to be performed hereunder and shall in no way prejudice the remaining provisions of this Agreement.

29. BINDING EFFECT

All rights conferred by this Agreement shall be binding upon, inure to the benefit of, and be enforceable by or against the respective successors and assigns of the parties hereto.

30. SEVERABILITY

If any provision of this Agreement, or the application of any such provision to any person or in any circumstance is held invalid, the application of such provision to any other person or in any other circumstance, and the remainder of this Agreement, shall not be affected thereby and shall remain in full effect.

31. DISPUTE RESOLUTION

The parties shall attempt in good faith to resolve any dispute arising out of or relating to this Agreement promptly by negotiation between the management of each party. If the matter has not been resolved within sixty (60) days of a party's request for negotiation, either party may initiate arbitration as provided herein.

Any controversy or claim arising out of or relating to this Agreement, or breach thereof, shall be settled by arbitration administered by the American Arbitration Association under its Commercial Arbitration Rules, and judgment on the award rendered by the arbitrator may be entered in any court having jurisdiction thereof.

Either party may make a demand for binding arbitration by filing with the American Arbitration Association a demand in writing signed by an officer of the complaining party. The parties shall agree upon one arbitrator which will be selected and appointed in accordance with the Commercial Rules of the American Arbitration Association. The arbitration shall take place in Lexington, KY.

32. HEADINGS

The headings in this Agreement are inserted for convenience only and shall not effect the construction hereof.

33. GENERAL

Although this Agreement contemplates notification by OWNER and acceptance thereof by CONTRACTOR, both in writing, before commencement of Work, it is specifically understood and agreed that any Work performed by CONTRACTOR for OWNER hereafter shall be under the terms hereof, unless (and only to the extent that) by specific written agreement other terms inconsistent herewith are agreed upon by the parties hereto with respect to such work.

VALVOLINE INSTANT OIL CHANGE

By: _____

By: _____

Title: _____

Title: _____

Contractor Performance Evaluation

Date of Assessment: _____

Originated by: _____

General Information

1. Name of Company: _____

Address Line 1: _____

Address Line 2: _____

City, State, Zip: _____

Country: _____

Telephone Number: _____

Fax Number: _____

2. Safety Evaluation Completed By:

Name: _____

Title: _____

Telephone: _____

Fax: _____

Organization Information

3. Describe Services Performed:

- Construction
- Construction Design
- Original Equipment Manufacturer and Installer
- Project Maintenance
- Maintenance

SIC Code:

- Original Equipment Manufacturer and Maintenance
- Service Work (e.g., Janitorial/clerical/etc.)
- Manpower and Resource
- Other

If other, please list: _____

4. Describe Additional Services Performed: _____

5. List other types of work within the services you normally perform that you subcontract to others:

6. List of major equipment (e.g. cranes, JLGs, forklifts) your company has available for work at this facility and the method of establishing competency to operate.

7. Do you normally employ?

- Union Personnel
 - Non-Union Personnel
- If union, list trades/locals:

Safety & Health Performance Section

1. Workers Compensation Experience Modification Rate (EMR) Data

a. EMR is:

- Interstate rate
- Intrastate rate
- Monopolistic State rate
- Dual rate

b. EMR for three last years:

2008 _____ 2007 _____ 2006 _____

c. State of Origin: _____

d. EMR Anniversary Date: _____ (format mm/dd/yyyy)

2. Injury and Illness Data:

a. Employee hours worked last three years (excluding subcontractors)

Hours/Year	2008	2007	2006
Field			
Total			

b. Provide the following data (excluding subcontractor) using your OSHA 300 Forms from the past three (3) years:

	2008		2007		2006	
Rating Category	No.	Rate	No.	Rate	No.	Rate
Work-related fatality. Rate = $\frac{\text{Total Col. G} \times 200,000}{\text{Total Employee Hours}}$						
Lost workday cases involving days away from work, or days of restricted work activity, or both. Rate = $\frac{\text{Total Col. H \& I} \times 200,000}{\text{Total Employee Hours}}$						
Lost workday case cases involving days away from work. Rate = $\frac{\text{Total Col. H} \times 200,000}{\text{Total Employee Hours}}$						
Cases involving medical treatment only. Rate = $\frac{\text{Total Col. J} \times 200,000}{\text{Total Employee Hours}}$						
Total OSHA Recordable Injury Rate. Rate = $\frac{(\text{Total Col. G \& H \& I \& J}) \times 200,000}{\text{Total Employee Hours}}$						

Notes: (1) Data should be the best available data applicable to the work in this region or area.

(2) If your company is not required to maintain OSHA 300 forms, please provide information from your Worker's Compensation insurance carrier itemizing all claims for the last three years.

3. Have you received any regulatory (EPA, OSHA, etc.) citations in the last three years?

Yes No

If Yes, please give details: _____

4. Are there any judgments, claims or suits pending or outstanding against your company? Yes No

If Yes, please give details: _____

5. Are you now or have you ever been involved in any bankruptcy or reorganization proceedings? Yes No

If Yes, please give details: _____

If Yes, please attach copies. _____

Safety & Health Management Section

1. Highest ranking safety/health professional in the company:

Name: _____

Title: _____

Telephone: _____

Fax: _____

2. Do you have or provide:

a. Full time Safety/Health Director -	Yes	No
b. Full time Site Safety/Health Supervisor -	Yes	No
c. Full time Job Safety/Health Coordinator -	Yes	No

3. Do you have or provide:

a. Company paid health insurance -	Yes	No
b. Company paid dental insurance -	Yes	No
c. Paid sick leave -	Yes	No
d. Safety/Health incentive program -	Yes	No
e. Company paid safety/health training -	Yes	No

Safety & Health Program & Procedures Section

1. Do you have a written Safety and Health Program: Yes No

(If No, proceed to question 3)

Does the program address the following key elements?

- Management commitment and expectations	Yes	No
- Employee participation	Yes	No

- Accountabilities and responsibilities for managers, supervisors, and employees	Yes	No
- Resources for meeting safety & health requirements	Yes	No
- Periodic safety and health performance appraisals for all employees	Yes	No
- Hazard recognition and control	Yes	No

2. Does the program include work practices and procedures such as:

a. Equipment Lockout and Tagout (LOTO)	Yes	No
b. Confined Space Entry	Yes	No
c. Injury & Illness Recording	Yes	No
d. Fall Protection	Yes	No
e. Personal Protective Equipment	Yes	No
f. Portable Electrical/Power Tools	Yes	No
g. Vehicle Safety	Yes	No
h. Compressed Gas Cylinders	Yes	No
i. Electrical Equipment Grounding Assurance	Yes	No
j. Powered Industrial Vehicles (Cranes, Forklifts, JLGs, etc)	Yes	No
k. Housekeeping	Yes	No
l. Accident/Incident Reporting	Yes	No
m. Unsafe Condition Reporting	Yes	No
n. Emergency Preparedness, including evacuation plan	Yes	No
o. Waste Disposal	Yes	No

3. Do you have written programs for the following:

a. Hearing Conservation	Yes	No
b. Respiratory Protection	Yes	No
Where applicable, have employees been:		
• Trained		
• Fit tested		
• Medically approved		
c. Hazard Communication	Yes	No
d. Program to support the contractor requirements of the OSHA Process Safety Management of Highly Hazardous Chemicals, Explosives and Blasting Agents Standard (29 CFR 1910).	Yes	No

4. Do you have a substance abuse program?

If Yes, does it include the following:

- Pre-employment Testing	Yes	No
- Random Testing	Yes	No
- Testing for Cause	Yes	No
- DOT Testing	Yes	No

5. Do your employees read, write, and understand English such that they can perform their job tasks safely without an interpreter? Yes No

If No, provide a description of your plan to assure that they can safely perform their jobs. _____

6. Medical**a. Do you conduct medical examinations for:**

- Pre-employment	Yes	No
- Preplacement Job Capability	Yes	No
- Pulmonary	Yes	No
- Respiratory	Yes	No

b. Describe how you will provide first aid and other medical services for your employees while on-site.

Specify who will provide this service: _____

c. Do you have personnel trained to perform first aid and CPR: Yes No**7. Do you hold site safety and health meetings for:**

Field Supervisors	Yes	No	If yes, Frequency
Employees	Yes	No	If yes, Frequency
New Hires	Yes	No	If yes, Frequency
Subcontractors	Yes	No	If yes, Frequency

If Yes, are the safety and health meetings documented? Yes No

8. Personal Protection Equipment (PPE)

a. Is applicable PPE provided for employees?	Yes	No
b. Do you have a program to assure that PPE is inspected and maintained?	Yes	No

9. Do you have a corrective action process for addressing individual safety and health performance deficiencies. Yes No**10. Equipment and Materials:**

a. Do you have a system for establishing applicable health, safety, and environmental specifications for acquisition of materials and equipment?	Yes	No
b. Do you conduct inspections on operating equipment (e.g., cranes, forklifts, JLGs) in compliance with regulatory requirements?	Yes	No
c. Do you maintain operating equipment in compliance with regulatory requirements?	Yes	No
d. Do you maintain the applicable inspection and maintenance certification records for operating equipment?	Yes	No

11. Subcontractors

a. Do you use safety and health performance criteria in selection of subcontractors?	Yes	No	N/A
b. Do you evaluate the ability of subcontractors to comply with applicable health and safety requirements as part of the selection process?	Yes	No	N/A
c. Do your subcontractors have a written Safety & Health Program?	Yes	No	N/A
d. Do you include your subcontractors in:	Yes	No	N/A
- Safety & Health Orientation	Yes	No	N/A

- Safety & Health Meeting	Yes	No	N/A
- Inspections	Yes	No	N/A
- Audits	Yes	No	N/A
12. Inspections and Audits			
a. Do you conduct safety and health inspections?	Yes	No	N/A
b. Do you conduct safety and health program audits?	Yes	No	N/A
c. Are corrections of deficiencies documented?	Yes	No	N/A

Safety & Health Training Section

1. Craft Training			
a. Have employees been trained in appropriate job skills?	Yes	No	N/A
b. Are employees job skills certified where required by regulatory or industry consensus standards?	Yes	No	N/A
c. List crafts which have been certified: _____			

2. Safety & Health Orientation	New Hires		Supervisors	
a. Do you have a Safety & Health Orientation Program for new hires and newly hired or promoted supervisors?	Yes	No	Yes	No
b. If Yes, does program provide instruction on the following:				
- New Worker Orientation	Yes	No	Yes	No
- Safe Work Practices	Yes	No	Yes	No
- Safety Supervision	Yes	No	Yes	No
- Toolbox Meetings	Yes	No	Yes	No
- Emergency Procedures	Yes	No	Yes	No
- First Aid Procedures	Yes	No	Yes	No
- Incident Investigation	Yes	No	Yes	No
- Fire Protection and Prevention	Yes	No	Yes	No
- Safety Intervention	Yes	No	Yes	No
c. If yes, how long is the orientation program?	Hours			
3. Safety & Health Training				
a. Do you know the regulatory safety and health training requirements for your employees?	Yes	No		
b. Have your employees received the required safety and health training and retraining?	Yes	No		
c. Do you have a specific safety and health training program for supervisors?	Yes	No		
4. Training Records				
a. Do you have safety and health and crafts training records for your employees?	Yes	No		
b. If yes, do the training records include the following:				
- Employee identification	Yes	No		
- Date of training	Yes	No		
- Name of trainer	Yes	No		
- Method used to verify understanding	Yes	No		
c. How do you verify understanding of training?				

- **Written test**
 - **Oral test**
 - **Performance test**
 - **Job Monitoring**
 - **Other (please list below)**
-
-
-

Date

XYZ, Inc
Sample Rd
USA
Attn. John Doe

Re: Valvoline Instant Oil Change

Dear John:

You are invited to submit a proposal to construct our prototype 3-bay Valvoline Instant Oil Change facility referenced above. A disk of bid drawings and specifications along with the geotechnical report are attached for your reference. Drawings have been submitted for permits to the city of USA. It is our intention to select the contractor based on the best overall proposal. The low bid is not necessarily the only criteria.

The building drawings reflect our new prototype design and it is recommend that you and your subcontractors carefully review the documents to avoid making erroneous assumptions based on any past work with VIOC. Your written proposal should be submitted on the enclosed proposal form and returned to my attention postmarked, faxed or e-mailed no later than midnight ????.

The following documents are included for your review:

- Contract to Furnish Labor, Supervision and Materials
- Bid Proposal Form - Exhibit A
- Equal Employment Opportunity Form - Exhibit B
- Owner Safety and Health Regulations - Exhibit C
- Ethical Standards Policy Statement - Exhibit D
- Bid Clarifications and Additions

Please be sure to complete the enclosed bid form completely. The accuracy and completeness of the form is an important aspect of the selection of the successful bidder. An electronic version will be forwarded to you. Any questions or comments regarding any of the enclosed information or the construction bid documents should be directed to

Sincerely,

VIOC Project Manager

SECTION 00100 - INSTRUCTIONS TO BIDDERS**TABLE OF ARTICLES**

1. Defined Terms
2. Bids Received
3. Location and Description of Project
4. Copies of Bidding Documents
5. Qualifications of Bidders
6. Examination of Contract Documents and Site
7. Interpretations and Addenda
8. Bid Security
9. Contract Time
10. Liquidated Damages
11. Substitute Materials and Equipment
12. Subcontractors and Others
13. (Not Used)
14. Preparation of Bid
15. Submission of Bid
16. Modification or Withdrawal of Bid
17. Opening of Bids
18. Disqualification of Bidders
19. Bids to Remain Subject to Acceptance
20. Award of Contract
21. Contract Securities
22. Contractor's Insurance
23. Execution of Agreement
24. Notice to proceed
25. Pre-Bid Conference

ARTICLE 1 - DEFINED TERMS

- 1.1 Terms used in these Instructions to Bidders, which are defined in the General and Supplementary Conditions, have the meanings assigned to them in the General and Supplementary Conditions. The term "Successful Bidder" means the Bidder to whom OWNER (on the basis of OWNER'S evaluation as hereinafter provided) makes an award.

ARTICLE 2 - BIDS RECEIVED**ARTICLE 3 - LOCATION AND DESCRIPTION OF PROJECT**

- 3.1 Refer to cover sheet CS-1 of drawings.

ARTICLE 4 - COPIES OF BIDDING DOCUMENTS

- 4.1 Refer to Notice to Bidders for information on examination and procurement of documents.
- 4.2 Complete sets of Bidding Documents shall be used in preparing Bids. Contractor shall confirm that all specifications and details listed are included in the bid documents provided by the OWNER.
- 4.3 OWNER is making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids for the Work and do not confer a license or grant for any other use.

ARTICLE 5 - QUALIFICATIONS OF BIDDERS

- 5.1 Bidders shall be experienced in the kind of Work to be performed, shall have the necessary equipment therefore, and shall possess sufficient capital to properly execute the Work within the time allowed. Bids received from Bidders who have previously failed to complete work within the time required, or who have previously performed similar work in an unsatisfactory manner, may be rejected.
- 5.2 As evidence of Bidder's qualifications to perform the Work, Bidder may be required to complete and submit with his Bid, an AIA Bidder's Qualification Statement. Low Bidders may be asked to furnish additional data to demonstrate their qualifications.
- 5.3 The Bid must contain evidence of Bidder's qualification to do business in the State of said work or covenant to obtain such qualification prior to execution of Agreement.

ARTICLE 6 - EXAMINATION OF CONTRACT DOCUMENTS AND SITE

- 6.1 Before submitting a Bid, Bidder shall (a) examine the Contract Documents thoroughly, (b) visit the site to familiarize itself with local conditions that may affect cost, progress, performance or furnishing of the Work, (c) familiarize itself with federal, state and local laws, ordinances, rules and regulations that may affect cost, progress, performance or furnishing of the Work, (d) examine the Contract Documents for other work to be performed on the Project that relates to the Work for which the Bid is to be submitted, with the Contract Documents, and (e) notify OWNER of any conflict, error, ambiguity or discrepancy in the Contract Documents of which Bidder becomes aware.
- 6.2 On request, OWNER will allow a site visit for the Bidder during OWNER'S normal business hours.
- 6.3 The submission of a Bid will constitute an incontrovertible representation by Bidder that it has complied with every requirement of this Article 6 and that the Contract Documents are efficient in scope and detail to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

- 7.1 All questions about the meaning or intent of the Bidding Documents or the Contract Documents shall be submitted to OWNER in writing. In order to receive consideration, questions must be received by OWNER no later than three days prior to the bid due date. The OWNER will not be responsible for oral interpretations or clarifications which anyone presumes to make on their behalf.
- 7.2 OWNER may issue such additional Addenda as may be necessary to clarify, correct or change the Bidding Documents or the Contract Documents.

ARTICLE 8 - BID SECURITY

- 8.1 The OWNER will keep confidential bid information received from the General Contractor.
- 8.2 The General Contractor and his subcontractors shall in no case share pricing with other contractors and subcontractors.

ARTICLE 9 - CONTRACT TIME

- 9.1 The dates by which the Work is to be substantially completed and completed (the Contract Time) are set forth in the Agreement.

ARTICLE 10 - LIQUIDATED DAMAGES

- 10.1 Provisions for liquidated damages, if any, are set forth in the Agreement.

ARTICLE 11 - SUBSTITUTE MATERIALS AND EQUIPMENT

- 11.1 Whenever it is indicated in the Drawings or specified in the Specifications that a substitute or "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to OWNER, application for such acceptance will not be considered by OWNER until after the Effective Date of the Agreement.

ARTICLE 12 - SUBCONTRACTORS AND OTHERS

- 12.1 CONTRACTOR shall submit with the Bid to OWNER a list of all Subcontractors and other persons and organizations proposed for the Work. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, person and organization if requested by OWNER.

ARTICLE 13 - (Not Used)

ARTICLE 14 - PREPARATION OF BID

- 14.1 A Bid must be made on OWNER'S Bid Form.
- 14.2 Blank spaces in the Bid Form must be filled in correctly where indicated, and the Bidder must state, both in words and numerals, the prices proposed for each and every item of Work.

ARTICLE 15 - SUBMISSION OF BID

- 15.1 Bids shall be mailed, faxed or e-mailed as directed in bid invitation letter.

ARTICLE 16 - MODIFICATION OR WITHDRAWAL OF BID

ARTICLE 17 - OPENING OF BIDS

- 17.1 Bids will be opened privately.
- 17.2 Bids received by mail, fax or e-mail, or otherwise after the time specified for the opening of Bids will not be accepted and will be disqualified.

ARTICLE 18 - DISQUALIFICATION OF BIDDERS

ARTICLE 19 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

- 19.1 All Bids shall remain subject to acceptance for sixty days after the day of the Bid opening.

ARTICLE 20 - AWARD OF CONTRACT

- 20.1 OWNER reserves the right to reject any or all Bids, to waive any and all informalities not involving price, time or changes in the Work, to negotiate contract terms with the Successful Bidder and the right to reject all nonconforming, nonresponsive or conditional Bids.
- 20.2 OWNER reserves the right to reject any Bid if it shows any omissions, alterations of form, additions not called for, conditions or qualifications, or irregularities of any kind.
- 20.3 OWNER reserves the right to accept any Bid deemed to be in the best interests of the Project even though the Bid chosen may result in the award of the Contract to a Bidder whose Bid is not, on a mathematical basis alone, the low Bid.

ARTICLE 21 - CONTRACT SECURITIES

- 21.1 N/A

ARTICLE 22 - CONTRACTOR'S INSURANCE

- 22.1 Sample requirements provided.
- 22.2 The General Contractor shall carry builders risk insurance coverage for the duration of the project.

ARTICLE 23 - EXECUTION OF AGREEMENT

- 23.1 The Successful Bidder, or its authorized representative, will be required to execute the Agreement within ten days from the date of the Notice of Award.
- 23.2 The OWNER will prepare the documents, and will identify, in the Notice of Award, the location at which the documents will be executed.

ARTICLE 24 - NOTICE TO PROCEED

- 24.1 Issuance of the Notice to proceed shall be as stated in Article 2 of the General Conditions.

ARTICLE 25 - PRE-BID CONFERENCE

- 25.1 Bidders may be required to attend a Pre-Bid Conference at the discretion of the OWNER.

BID CLARIFICATIONS & ADDITIONS

Date

Valvoline Instant Oil Change
Sample Rd
USA

The following information is provided as supplementary to the bid construction drawings and specifications. This information is provided to clarify certain items in the bid documents and to provide inclusion of additional items not mentioned in the bid documents.

PROPOSAL REQUIREMENTS

- 1.
- 2.
- 3.

BUILDING

- 1.
- 2.
- 3.

SITE

- 1.
- 2.
- 3.

MISCELLANEOUS

- 1.

SECTION 00222 – Geotechnical Report

TO BE PROVIDED SEPARATELY BY OWNER

Description	Line Item Code	Sum	Amount
1 - Ground Up	Aggregate		
General Conditions	1	\$0.00	
Division 0 - General Conditions	1.2	\$0.00	
Temporary Facilities	1.2.1		
Temporary Utilities	1.2.2		
Insurance	1.2.3		
Supervision (On-site & Project Management)	1.2.4		
Materials Testing	1.2.5		
Permits	1.2.6		
Site Security	1.2.7		
Bond - If Required	1.2.8		
Permits - Misc. Contractor/ Trade Permits	1.2.9		
Tax	1.2.10		
Site Work	2	\$0.00	
Div 1 - Earthwork	2.2	\$0.00	
Building Demolition	2.2.1		
Foundation demolition	2.2.2		
Paving demolition	2.2.3		
Utility demolition	2.2.4		
Clearing & Grubbing	2.2.5		
Excavation	2.2.6		
Fill	2.2.7		
Topsoil	2.2.8		
Rock Excavation	2.2.9		
Haul Off	2.2.10		
Construction Dewatering (Refer to Exhibit D)	2.2.11		
Soil Stabilization	2.2.12		
Erosion Control	2.2.13		
Div 2 - CONCRETE	2.3	\$0.00	
Concrete Curb	2.3.1		
Asphalt Curb	2.3.2		
Sidewalks	2.3.3		
Dumpster Pad and Apron	2.3.4		
Building Aprons	2.3.5		
Pylon Base	2.3.6		
Light Base	2.3.7		
Other	2.3.8		
Div 3 - PAVING	2.4	\$0.00	
Concrete Paving	2.4.1		
Asphalt Paving	2.4.2		
Concrete Driveway Approaches	2.4.3		
Striping & Directional Arrows	2.4.4		
Bumper Blocks	2.4.5		
Asphalt Seal Coating	2.4.6		
Div 4 - SITE UTILITIES	2.5	\$0.00	
Storm Sewer	2.5.1		
Manholes	2.5.2		
Catch Basins	2.5.3		
Water Main	2.5.4		
Sanitary Sewer	2.5.5		
Gas Line	2.5.6		
Electric Service	2.5.7		
Phone Service	2.5.8		
Pylon / Monument Sign Electrical	2.5.9		
Site Light Conduit & Electrical	2.5.10		
Site Camera Installation	2.5.11		
Div 5 - SITE MICELLANEOUS	2.6	\$0.00	
Landscaping (plants, fine grade, etc.)	2.6.1		
Turf Establishment (sod, seed, hydromulch, etc.)	2.6.2		
Trash Enclosure	2.6.3		
Steel Bollards	2.6.4		
Irrigation sprinklers	2.6.5		
Retaining Wall	2.6.6		
Screen Fence	2.6.7		
Other	2.6.8		
Building	3	\$0.00	
Appropriation - Building	3.1	\$0.00	
Appropriation - Building	3.1.1		
Div 6 - CONCRETE	3.2	\$0.00	
Footings/Foundation	3.2.1		
Concrete Building Slab	3.2.2		
Precast Concrete w/ Deck	3.2.3		
Composite Deck	3.2.4		
Other	3.2.5		
Div 7 - MASONRY	3.3	\$0.00	
Block	3.3.1		
Brick	3.3.2		
Stucco /EFIS	3.3.3		
Div 8 - METALS	3.4	\$0.00	
Structural Steel	3.4.1		
Pit Steel & Stairs	3.4.2		
Misc. Steel (Lintels, roof, deck, bollards etc.)	3.4.3		
Div 9 - WOOD & PLASTICS	3.5	\$0.00	
Rough Carpentry	3.5.1		
Finish Carpentry	3.5.2		
Cabinets & Counters	3.5.3		
Other	3.5.4		
Div 10 - THERMAL & MOISTURE PROTECTION	3.6	\$0.00	
Shingle Roof	3.6.1		
Other type:	3.6.2		
Drain Tile	3.6.3		
Sheet Metal Flashing	3.6.4		
Waterproofing	3.6.5		
Gutters & Down Spouts	3.6.6		
Insulation:	3.6.7		
Div 11 - DOORS & WINDOWS	3.7	\$0.00	
Overhead Doors	3.7.1		
Store Front (Door & Window)	3.7.2		
Hollow Metal Doors & Frames	3.7.3		
Finish Hardware	3.7.4		
Div 12 - FINISHES	3.8	\$0.00	
Interior Painting	3.8.1		
Exterior Painting	3.8.2		
Drywall	3.8.3		
Ceiling Tile	3.8.4		
Service Bay Floor Finish type:	3.8.5		
Waiting & Restroom Floor Finish	3.8.6		
Basement/Storage/ Floor Finish	3.8.7		
Exterior Finish Special	3.8.8		
FRP Wall Finish	3.8.9		
Div 13 - SPECIALTIES	3.9	\$0.00	
Floor Safe (Corporate Safe-Model MB2014K-SG4440)	3.9.1		
Shelving	3.9.2		
Toilet Accessories	3.9.3		
Lockers	3.9.4		
Installation of Owner Furnished Equipment	3.9.5		
Other	3.9.6		
Div 14 - MECHANICAL	3.10	\$0.00	
Radiant Heat or Electric Heat	3.10.1		
HVAC (Specify Type)	3.10.2		
Test & Balance	3.10.3		
Plumbing (Including oil/water separator, water cooler, hands free eye wash station)	3.10.4		
Oil Process Piping	3.10.5		
Sprinkler System (Fire) type:	3.10.6		
Fire Extinguishers	3.10.7		
Other	3.10.8		
Div 15 - ELECTRICAL	3.11	\$0.00	
Building Electrical (Incl. all Fixtures, wiring of site, bldg signs & phone/pos/security/camera)	3.11.1		
Other	3.11.2		
Winter conditions	3.12	\$0.00	
Winter conditions	3.12.1		

General Conditions
General Conditions
Overhead & Profit
Overhead & Profit

3.13
3.13.1
3.14
3.14.1

\$0.00
\$0.00

**EQUAL OPPORTUNITY
CERTIFICATION AND AGREEMENTS**

I. EQUAL OPPORTUNITY CLAUSE

(Applicable to all contracts or purchase orders in excess of \$10,000).

Seller shall be bound by and agrees to the following provisions as contained in Section 202 of Executive Order 11246, to wit:

1. The Supplier/Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Supplier/Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action will include, but not be limited to the following: employment, upgrading, demotion, or transfer, recruitment advertising, layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Supplier/Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.
2. The Supplier/Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Supplier/Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.
3. The Supplier/Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided by the agency contracting officer, advising the labor union or workers' representative of the Supplier/Contractor's commitments under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notices in conspicuous places available to employees and applicants for employment.
4. The Supplier/Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.
5. The Supplier/Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the Supplier/Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations or orders, this Purchase Order/Contract may be canceled, terminated or suspended in whole or in part and the Supplier/Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation or order of the Secretary of Labor, or as otherwise provided by law.
7. The Supplier/Contractor will include the provisions of paragraphs (1) through (7) in every Subcontract or Purchase Order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each Subcontractor or Vendor. The Supplier/Contractor will take such action with respect to any Subcontract or Purchase Order as may be directed by the Secretary of Labor as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the Supplier/Contractor becomes involved in, or is threatened with, litigation with a Subcontractor or Vendor as a result of such direction the Supplier/contractor may request the United States to enter into such litigation to protect the interests of the United States.

II. CERTIFICATION OF NON-SEGREGATED FACILITIES

Supplier/Contractor certifies that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity Clause in this contract. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms, and wash rooms, restaurants and other eating areas, time clocks, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit direction or are in fact segregated on the basis of race, creed, color or national origin, because of habit, local custom, or otherwise. It further certifies that (except where it has obtained identical certifications from proposed subcontractors for specific time periods) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts which are not exempt from the provisions of the Equal Opportunity Clause; that it will retain such certification in its files; and that it will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods).

"NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NON-SEGREGATED FACILITIES"

A certification of Non-segregated Facilities must be submitted before the award of a subcontract under which the subcontractor will be subject to the Equal Opportunity Clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semi-annually or annually).

Note: The penalty for making false statements in offers is prescribed in 18 U.S.C 1001.

III. EMPLOYER INFORMATION REPORT AND AFFIRMATIVE ACTION PROGRAM

Supplier/Contractor agrees that if the amount of this contract is \$50,000 or more and it employs 50 or more persons it shall:

- (a) File with the Office of Federal Contract Compliance or agency designated by it, a complete and accurate report on Standard Form 100 (EEO-1) within 30 days after receiving an award of this contract (unless such a report has been filed in the last 12 months), and continue to file such reports annually, on or before March 31st.
- (b) Develop and maintain a written affirmative action compliance program for each of its establishments in accordance with the regulations of the Secretary of Labor promulgated under Executive Order 11246, as amended.

IV. AFFIRMATIVE ACTION FOR DISABLED VETERANS AND VETERANS OF THE VIETNAM ERA

(applicable to all contracts or purchase orders in excess of \$10,000)

- (a) The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or Veteran of the Vietnam era in regard to any position for which the employee or applicant for employment is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified disabled veterans and veterans of the Vietnam era without discrimination based upon their disability or veterans status in all employment practices such as the following: Employment upgrading, demotion or transfer, recruitment, advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship.

- (b) The contractor agrees that all suitable employment openings of the contractor which exist at the time of the execution of this contract and those which occur during the performance of this contract, including those not generated by this contract and including those occurring at an establishment of the contractor other than the one wherein the contract is being performed but excluding those of independently operated corporate affiliates, shall be listed at an appropriate location office of the State employment service system wherein the opening occurs. The contractor further agrees to provide such reports to such local office regarding employment openings and hires as may be required.

State and local government agencies holding Federal contracts of \$100,000 or more shall also list all their suitable openings with the appropriate office of the State employment service. but are not required to provide those reports set forth in paragraphs (d) and (e).

- (c) Listing of employment openings with the employment service system pursuant to this clause shall be made at least concurrently with the use of any other recruitment source or effort and shall involve the normal obligations which attach to the placing of a bona fide job order, including the acceptance of referrals of veterans and non-veterans. The listing of employment openings does not require the hiring of any particular job applicant or from any particular group of job applicants, and nothing herein is intended to relieve the contractor from any requirements in Executive Orders or regulations regarding nondiscrimination in employment.
- (d) The reports required by paragraph (b) of this clause shall include, but not be limited to, periodic reports which shall be filed at least quarterly with the appropriate local office or, where the contractor has more than one hiring location in a State, with the central office of that State employment service. Such reports shall indicate for each hiring location (1) the number of individuals hired during the reporting period, (2) the number of non-disabled veterans of the Vietnam era hired, (3) the number of disabled veterans of the Vietnam era hired, and (4) the total number of disabled veterans hired. The reports should include covered veterans hired for on-the-job training under 38 U.S.C. 1787. The contractor shall submit a report within 30 days after the end of each reporting period wherein any performance is made on this contract identifying data for each hiring location. The contractor shall maintain at each hiring location copies of the reports submitted until the expiration of one year after final payment under the contract, during which time these reports and related documentation shall be made available, upon request, for examination by any authorized representatives of the contracting officer or of the Secretary of Labor. Documentation would include personnel records respecting job openings, recruitment and placement.
- (e) Whenever the contractor becomes contractually bound to the listing provisions of this clause, it shall advise the employment service system in each State where it has establishments of the name and location of each hiring location in the State. As long as the contractor is contractually bound to these provisions and has so advised the State system, there is no need to advise the State system of subsequent contracts. The contractor may advise the State system when it is no longer bound by this contract clause.
- (f) This clause does not apply to the listing of employment openings which occur and are filled outside of the 50 States, the District of Columbia, Puerto Rico, Guam, and the Virgin Islands.
- (g) The provisions of paragraphs (b), (c), (d), and (e) of this clause do not apply to openings which the contractor proposes to fill from within his own organization or to fill pursuant to a customary and traditional employer-union hiring arrangement. This exclusion does not apply to a particular opening once an employer decides to consider applicants outside of his own organization or employer-union arrangement for that opening.
- (h) As used in this clause:

- (1) “All suitable employment openings” includes, but is not limited to, openings which occur in the following job categories: Production and non-production; plant and office; laborers and mechanics; supervisory and non-supervisory; technical; and executive, administrative and professional openings as are compensated on a salary basis of less than \$25,000 per year. This term includes full-time employment, temporary employment of more than 3 days’ duration, and part-time employment. It does not include openings which the contractor proposes to fill from within his own organization or to fill pursuant to a customary and traditional employer-union hiring arrangement nor openings in an educational institution which are restricted to students of that institution. Under the most compelling circumstances an employment opening may not be suitable for listing, including such situations where the needs of the Government cannot reasonably be otherwise supplied, where listing would be contrary to national security, or where the requirement of listing would otherwise not be for the best interest of the Government.
 - (2) “Appropriate office of the State employment service system” means the local office of the Federal-State national system of public employment offices with assigned responsibility for serving the area where the employment opening is to be filled, including the District of Columbia, Guam, Puerto Rico. and the Virgin Islands.
 - (3) “Openings which the contractor proposes to fill from within his own organization” means employment openings for which no consideration will be given to persons outside the contractor’s organization (including any affiliates, subsidiaries, and the parent companies) and includes any openings which the contractor proposes to fill from regularly established “recall” lists.
 - (4) “Openings which the contractor proposes to fill pursuant to a customary and traditional employer-union hiring arrangement” means employment openings which the contractor proposes to fill from union halls, which is part of the customary and traditional hiring relationship which exists between the contractor and representatives of his employees.
- (i) The contractor agrees to comply with the rules, regulations, and relevant orders of the Secretary of Labor issued pursuant to the Act.
 - (j) In the event of the contractors noncompliance with the requirements of this clause, actions for noncompliance may be taken in accordance with the rules, regulations. and relevant orders of the Secretary of Labor issued pursuant to the Act.
 - (k) The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices in a form to be prescribed by the Director, provided by or through the contracting officer. Such notice shall state the contractor’s obligation under the law to take affirmative action to employ and advance in employment qualified disabled veterans and veterans of the Vietnam era for employment, and the rights of applicants and employees.
 - (l) The contractor will notify each labor union or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the contractor is bound by the terms of the Vietnam Era Veterans Readjustment Assistance Act, and is committed to take affirmative action to employ and advance in employment qualified disabled veterans and veterans of the Vietnam era.
 - (m) The contractor will include the provisions of this clause in every subcontract or purchase order of \$10,000 or more unless exempted by rules, regulations, or orders of the Secretary issued pursuant to the Act, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the Director of the Office of Federal Contract Compliance Programs may direct to enforce such provisions, including action for noncompliance.

**V. UTILIZATION OF SMALL BUSINESS
CONCERNS AND SMALL
DISADVANTAGED BUSINESS CONCERNS**

- (a) It is the policy of the United States that small business concerns and small business concerns owned and controlled by socially and economically disadvantaged individuals shall have the maximum practicable opportunity to participate in performing contracts let by any Federal agency, including contracts and subcontracts for subsystems, assemblies, components, and related services for major systems. It is further the policy of the United States that its prime contractors establish procedures to ensure the timely payment of amounts due pursuant to the terms of their subcontracts with small business concerns and small business concerns owned and controlled by socially and economically disadvantaged individuals.
- (b) The Contractor hereby agrees to carry out this policy in the awarding of subcontracts to the fullest extent consistent with efficient contract performance. The contractor further agrees to cooperate in any studies or surveys as may be conducted by the United States Small Business Administration or the awarding agency of the United States as may be necessary to determine the extent of the Contractor's compliance with this clause.
- (c) As used in this contract, the term "small business concern" shall mean a small business as defined pursuant to section 3 of the Small Business Act and relevant regulations promulgated pursuant thereto. The term "small business concern owned and controlled by socially and economically disadvantaged individuals" shall mean a small business concern (1) which is at least 51 percent unconditionally owned by one or more socially and economically disadvantaged individuals, or, in the case of any publicly owned business, at least 51 per centum of the stock of which is unconditionally owned by one or more socially and economically disadvantaged individuals; and (2) whose management and daily business operations are controlled by one or more of such individuals. This term also means a small business concern that is at least 51 percent unconditionally owned by an economically disadvantaged Indian tribe or Native Hawaiian organization, or a publicly owned business having at least 51 percent of its stock unconditionally owned by one of these entities which has its management and daily business controlled by members of an economically disadvantaged Indian Tribe or Native Hawaiian Organization, and which meets the requirements of 13 CFR 124. The Contractor shall presume that socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, and other minorities, or any other individual found to be disadvantaged by the Administration pursuant to section 8(a) of the Small Business Act. The Contractor shall presume that socially and economically disadvantaged entities also include Indian Tribes and Native Hawaiian Organizations.
- (d) Contractors acting in good faith may rely on written representations by their subcontractors regarding their status as either a small business concern or a small business concern owned and controlled by socially and economically disadvantaged individuals.

VI. UTILIZATION OF WOMEN-OWNED SMALL BUSINESSES

- (a) It is the policy of the United States that women-owned small businesses shall have the maximum practicable opportunity to participate in performing contracts awarded by any federal agency.
- (b) The contractor agrees to use its best efforts to give women-owned small businesses the maximum practicable opportunity to participate in the subcontracts it awards to the fullest extent consistent with the efficient performance of its contract.

VII. AFFIRMATIVE ACTION FOR HANDICAPPED WORKERS
(applies to all contracts or purchase orders in excess of \$2,500)

- (a) The contractor will not discriminate against any employee or applicant for employment because of physical or mental handicap in regard to any position for which the employee or applicant for employment is qualified. The contractor agrees to take affirmative action to employ, advance in employment and otherwise treat qualified handicapped individuals without discrimination based upon their physical or mental handicap in all employment practices such as the following: Employment, upgrading, demotion or transfer, recruitment, advertising, layoff or termination, rates of pay or other forms of compensation, and selection for training, including apprenticeship.
- (b) The contractor agrees to comply with the rules, regulations and relevant orders of the Secretary of Labor issued pursuant to the Act.
- (c) In the event of the contractor's noncompliance with the requirements of this clause, actions for noncompliance may be taken in accordance with the rules, regulations, and relevant orders of the Secretary of Labor. issued pursuant to the Act.
- (d) The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices in a form to be prescribed by the Director provided by or through the contracting officer. Such notices shall state the contractor's obligation under the law to take affirmative action to employ and advance in employment qualified handicapped employees and applicants for employment, and the rights of applicants and employees.
- (e) The contractor will notify each labor union or representative of workers with which it has a collective bargaining agreement or other contract understanding, that the contractor is bound by the terms of section 503 or the Rehabilitation Act of 1973, and is committed to take affirmative action to employ and advance in employment physically and mentally handicapped individuals.
- (f) The contractor will include the provisions of this clause in every subcontract or purchase order of \$2,500 or more unless exempted by rules, regulations, or orders of the Secretary issued pursuant to section 503 of the Act, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the Director of the Office of Federal Contract Compliance Programs may direct to enforce such provisions, including action for non-compliance.

Company Name:

Address:
City, State, Zip:
United States

Date:

Agreed to and Certified By:

Authorized Signature

Name of Authorized Representative

TITLE OF AUTHORIZED REPRESENTATIVE

ACORD CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY)

PRODUCER	THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.	
	INSURERS AFFORDING COVERAGE	NAIC #
	INSURER A:	
	INSURER B:	
	INSURER C:	
INSURED	INSURER D:	
	INSURER E:	

COVERAGES

THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. AGGREGATE LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR ADD'L LTR INSRD	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS		
A	GENERAL LIABILITY	BC0106417600	01/01/2009	01/01/2010	EACH OCCURRENCE	\$ 1,000,000	
	☒ COMMERCIAL GENERAL LIABILITY				DAMAGE TO RENTED PREMISES (Ea occurrence)	\$ 200,000	
	☐ CLAIMS MADE ☒ OCCUR				MED EXP (Any one person)	\$ 10,000	
					PERSONAL & ADV INJURY	\$ 1,000,000	
					GENERAL AGGREGATE	\$ 2,000,000	
					PRODUCTS - COMP/OP AGG	\$ 2,000,000	
	GEN'L AGGREGATE LIMIT APPLIES PER:						
	☐ POLICY ☐ PRO-JECT ☐ LOC						
A	AUTOMOBILE LIABILITY	BC0106417600	01/01/2009	01/01/2010	COMBINED SINGLE LIMIT (Ea accident)	\$ 1,000,000	
	☒ ANY AUTO				BODILY INJURY (Per person)	\$	
	☐ ALL OWNED AUTOS				BODILY INJURY (Per accident)	\$	
	☐ SCHEDULED AUTOS				PROPERTY DAMAGE (Per accident)	\$	
	☐ HIRED AUTOS						
	☐ NON-OWNED AUTOS						
	GARAGE LIABILITY				AUTO ONLY - EA ACCIDENT	\$	
	☐ ANY AUTO				OTHER THAN EA ACC	\$	
					AUTO ONLY: AGG	\$	
A	EXCESS/UMBRELLA LIABILITY	BC0106417600	01/01/2009	01/01/2010	EACH OCCURRENCE	\$ 5,000,000	
	☒ OCCUR ☐ CLAIMS MADE				AGGREGATE	\$ 5,000,000	
	☐ DEDUCTIBLE					\$	
	☒ RETENTION \$ 10,000					\$	
						\$	
B	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY	060348	01/01/2009	01/01/2010	☒ WC STATU-TORY LIMITS ☐ OTH-ER		
	E L. EACH ACCIDENT				\$ 500,000		
	E L. DISEASE - EA EMPLOYEE				\$ 500,000		
	E L. DISEASE - POLICY LIMIT				\$ 500,000		
	ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED?						
	If yes, describe under SPECIAL PROVISIONS below						
	OTHER						

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES / EXCLUSIONS ADDED BY ENDORSEMENT / SPECIAL PROVISIONS
Waiver of Subrogation applies. Certificate Holder is Additional Insured as their interest appears
Insurance is Primary.

CERTIFICATE HOLDER

Valvoline Instant Oil Change
A Division of Valvoline, LLC.
Attn:
P.O. Box 14046
Lexington, KY 40512

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING INSURER WILL ENDEAVOR TO MAIL 10 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE INSURER, ITS AGENTS OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE

Sharon Holden/GINNY

CONTRACTOR SAFETY AND HEALTH REGULATIONS

Accident, fire and exposure prevention are essential elements in the operation of all Valvoline LLC., its subsidiaries and affiliates (herein called "Valvoline") plants, All personnel, independent contractors and visitors, while within the confines of our plants, are required to wear certain protective equipment and comply with established safety and health regulations. Independent contractors, performing work or services at any company facility under contract from Valvoline, are expected to perform all work or services in a safe, healthful and efficient manner, so as to prevent injury to their employees or damage to their equipment and to protect Valvoline's employees and property.

All independent contractors, under their contract with Valvoline, have agreed to adhere to and abide by the General Fire, Safety and Health Regulations promulgated by Valvoline with respect to contractor work. The purpose of this memorandum and the Regulations attached hereto is to familiarize the contractor with these Regulations so he may become aware of the requirements expected of him and take steps to educate his employees with respect to their on-the-job conduct.

To promote safe work and to develop safety and health awareness in the workpeople, we feel that safety meetings are important. A short "tailgate" meeting each morning will contribute greatly to this. Naturally, follow-up by supervisors during daily contact should be done.

After you have had an opportunity to review the attached Regulations, representatives of this Department will be happy to discuss with you any questions you may have concerning your particular work or service.

CONTRACTOR: SIGN HERE

I have read and understand the Contractor Safety and Health Regulations cited above and I certify that Valvoline has advised me, in accordance with the Federal Hazard communication standard, as to the hazards, if any, associated with chemicals located in the workplace to which the Contractor's employees may be exposed.

signed for contractor by:

signature

title

name of contracting firm:

date

GENERAL FIRE, SAFETY AND HEALTH REGULATIONS CONTRACT WORK

1. SMOKING:

Smoking is absolutely prohibited at all times in locations where **NO SMOKING** signs are exhibited

No smoking is permitted inside the plant property fenced area other than in designated smoking areas. A special smoking area may be arranged by Valvoline's safety personnel for contract employees due to location and number of employees.

2. FIRE PROTECTION

A permit to perform hot work of any kind is required at all locations in the plant other than in Company shop buildings. Special hot work permits can be obtained for contractor welding at fabrication sites; however, all other hot work will require a hot work permit which can be obtained from a person designated by local safety personnel, and in no event will hot work be performed until such permit is granted.

The contractor shall furnish approved fire extinguishers for fire protection. If this equipment is to be furnished by Valvoline pursuant to the contract, it may be obtained from the local safety personnel.

Company fire equipment located throughout the plant should be used only in the event of a fire. This fire equipment must be kept in place and free from obstructions at all times.

The plant fire water systems are reserved for fire fighting purposes. If abnormal circumstances make it necessary that fire water be used for filling tanks, etc., special arrangements must be made with the company.

3. HOUSEKEEPING

The contractor shall be expected to maintain a clean work place at all times for the safety of his employees Valvoline employees and others.

A clean and tidy plant is a safe plant. Do not permit any refuse to accumulate. Pile material neatly and safely, keeping material a safe distance from fire fighting equipment, roads, sewer manholes, side-walks and operating facilities where employees have to travel to perform their work assignments. Do not leave tools and loose materials on steps, walkways, platforms or on elevated equipment. Place proper guard rails or barricades around openings, trenches and objects that protrude into walkways or roadways. The contractor is required to furnish labor needed to keep area clean, including workers' lunch refuse.

4. SAFETY

The contractor shall be expected to perform safe work at all times. All personnel within the confines of our plants, including visitors, and contractors and their employees, agents or representatives, are required to wear safety hats and proper eye protection. It is the responsibility of the contractors to insure personal protective equipment is provided and worn by their employees.

To prevent personal injury, scaffolding and shoring should be provided where work to be performed requires it, to protect against falls, falling objects and cave-ins. Regulation handrails, toe boards and ladders must be provided where necessary or required. When working above ground, safety belts shall be worn as required. Do not throw or drop tools or equipment. Install signs and rope off areas in which there is danger from falling objects.

Guy wires, hoisting cables or tackle lines shall not be anchored to in-service pipe lines or equipment vulnerable to stress.

Electrical equipment tie-ins must be coordinated with Valvoline's operations. Electrical problems should be worked out to the best safe advantage by the contractor's and company's electrical departments. Electric lockout procedure shall be followed when working on any electric equipment.

A vessel entry permit must be obtained by Contractor foremen for work to be performed in tanks, vessels, sewer manholes and similar confined areas.

Only authorized contractor vehicles will be permitted in the plant. No vehicle shall be driven in excess of 15 miles per hour. Special permits will be required when vehicles are needed in operating unit areas, inside tank dike walls, etc.

5. OSHA

All contractors will conform to and comply with the guidelines and regulations promulgated by OSHA pursuant to the Occupational Safety and Health Act as well as all other applicable Federal, State and Local laws and safety and health regulations. All references contained within the statement of safety and health regulations as to proper equipment and as to methods of operation are based upon the Regulations and Standards recited in the Federal Occupational Safety and Health Act, and promulgated pursuant thereto.

6. GENERAL

It is understood that the above general rules and regulations, plus other specific safety and health practices that may be instituted from time to time, are included in the conditions agreed to by the contract at the time of signing the contract for the work involved.

7. FEDERAL HAZARD COMMUNICATION

Valvoline has an affirmative duty, imposed by the Federal Hazard Communication Standard (48 FR 5334), to fully advise contractor as to the hazards, if any, of exposure to chemicals associated with contractor's work in the workplace. Valvoline shall comply with this requirement by providing all necessary information with respect to such hazards to appropriate Contractor's representative before Contractor's employees are permitted on-site to commence work.

SECTION 01011 - GENERAL CONDITIONS**TABLE OF ARTICLES**

1. Definitions
2. Preliminary Matters
3. Contract Documents: Intent and Reuse
4. Availability of Lands; Physical Conditions; Reference Points
5. Bonds and Insurance
6. Contractor's Responsibilities
7. Work by Others
8. Owner's Responsibilities
9. Engineer's Status During Construction
10. Changes in the Work
11. Change of Contract Price
12. Change of Contract Time
13. Warranty and Guarantee; Tests and Inspections; Correction, Removal or Acceptance of Defective Work
14. Payments to Contractor and Completion
15. Suspension of Work and Termination
16. Dispute Resolution
17. Miscellaneous

ARTICLE 1 - DEFINITIONS

- A)** Wherever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated which are applicable to both the singular and plural thereof.

a. Defined Terms:

Addenda: Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change, the Bidding Documents or the Contract Documents.

Agreement: The written agreement between OWNER and CONTRACTOR covering the Work to be performed; all other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

Application for Payment: The form accepted by OWNER which is to be used by CONTRACTOR in requesting progress or final payment and which is to include such supporting documentation as is required by the Contract Documents.

Bid: The offer or proposal of the Bidder submitted on the prescribed form setting forth the price(s) for the Work to be performed.

Bidder: Any person, firm or corporation submitting a Bid for the Work.

Bidding Documents: Notice to bidders or advertisement, if any, instructions to bidders, other bidding information and requirements, bidding forms and attachments, contract and bond forms, and the proposed Contract Documents, including any Addenda issued prior to receipt of Bids.

Bonds: Bid, Performance, and Payment bonds and other instruments of security.

Change Order: A written order to CONTRACTOR signed by OWNER authorizing an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Time issued after the Effective Date of the Agreement.

Contract Documents: The Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR'S Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications, the Drawings as the same may be more specifically identified in the Agreement, together with all Modifications issued after execution of the Agreement.

Contract Price: The moneys payable by OWNER to CONTRACTOR under the Contract Documents as stated in the Agreement (subject to the provisions of Paragraph 11.7 in the case of Unit Price Work).

Contract Time: The number of days (computed as provided in Paragraph 17.2) or the date stated in the Agreement for the completion of the Work.

CONTRACTOR: The person, firm or cooperation with whom OWNER has executed the Agreement. Whenever the Project is to be remediated under multiple direct contracts, the term "CONTRACTOR" shall mean the appropriate prime CONTRACTOR. Whenever a specific prime CONTRACTOR is referred to, terms such as "General CONTRACTOR", "Electrical CONTRACTOR", etc. will be used.

day: A calendar day of twenty-four hours measured from midnight to the next midnight.

defective: An adjective which when modifying the Work refers to Work that is unsatisfactory, faulty or deficient, or does not conform to the Contract Documents or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to OWNER's recommendation for final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with Paragraph 14.5).

Drawings: The Drawings which show the character and scope of the Work to be performed and which have been prepared or approved by OWNER and are referred to in the Contract Documents.

Effective Date of the Agreement: The date indicated in the Agreement on which it becomes effective, but if no such date is indicated, it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

OWNER: The person, firm or cooperation named as such in the Agreement.

Field Order: A written order issued by OWNER which orders minor changes in the Work in accordance with Paragraph 10.2 but which does not involve a change in the Contract Price or the Contract Time.

General Requirements: Sections of Division 1 of the Specifications.

Modifications: (a) A written amendment of the Contract Documents signed by both parties, (b) a Change Order, or (c) a Field Order. A Modification may only be issued after the Effective Date of the Agreement.

Notice of Award: The written notice by OWNER to the apparent successful Bidder stating that upon compliance by the apparent successful Bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.

Notice to Proceed: A written notice given by OWNER to CONTRACTOR fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform his obligations under the Contract Documents.

OWNER: The public body or authority, corporation, association, partnership, or individual with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be provided.

Project: The total remediation of which the Work to be provided under the Contract Documents may be the whole or a part as indicated elsewhere in the Contract Documents.

Project Manual: The bound documentary information prepared for bidding and remediating the Project. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

N/A

Samples: Physical examples furnished by the CONTRACTOR to illustrate materials, equipment or workmanship, and to establish standards by which some portions of the Work will be judged.

Shop Drawings: All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for CONTRACTOR to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a manufacturer, fabricator, supplier or distributor and submitted by CONTRACTOR to illustrate material or equipment for some portion of the Work.

Specifications: Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

Subcontractor: An individual, firm or cooperation having a direct contract with the CONTRACTOR or with any Subcontractor for the performance of a part of the Work at the site.

Substantial Completion: The Work (or a specified part thereof) has progressed to the point where, in the opinion of OWNER the project is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it was intended; or if there be no such certificate issued, when final payment is due in accordance with

Paragraph 14.9.A. The terms "substantially complete" and "substantially completed" as applied to any Work refer to Substantial Completion thereof.

Supplementary Conditions: Modifications and additions to the General Conditions.

Unit Price Work: Work to be paid for on the basis of unit prices contained in the Contract Documents.

Work: The entire completed remediation or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, and all as required by the Contract Documents.

ARTICLE 2 - PRELIMINARY MATTERS

A) N/A

B) Copies of Documents

- a. OWNER shall furnish CONTRACTOR a disk of the bid and construction documents for hard copy reproduction by the CONTRACTOR.

C) Commencement of Contract Time; Notice to Proceed:

D) The Contract Time will commence to run on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within thirty days after the Effective Date of the Agreement.

E) Starting the Project:

CONTRACTOR shall start to perform the Work on the date when the Contract Time commences to run, but no Work shall be done at the site prior to the date on which the Contract Time commences to run.

A) Before Starting Construction:

Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to OWNER any conflict, error or discrepancy which he may discover and shall obtain a written interpretation or clarification from OWNER before proceeding with any work affected thereby.

A) Preconstruction Conference

Within two days after the Effective Date of the Agreement, but before CONTRACTOR starts the Work at the site, a conference will be held for review and acceptance of the schedules, referred to in Paragraph 2.5.B, to establish procedures for handling Shop Drawings and other submittals and for processing Applications for Payment, and to establish a working understanding among the parties as to the Work.

ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AND REUSE

A) Intent:

- a. The Contract Documents comprise the entire Agreement between OWNER and CONTRACTOR concerning the Work. They may be altered only by a Modification.

- b. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. If, during the performance of the Work, CONTRACTOR finds a conflict, error or discrepancy in the Contract Documents, he shall report it to OWNER in writing at once and before proceeding with the Work affected thereby.
- c. It is the intent of the Specifications and Drawings to describe a complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work that may reasonably be inferred from the Specifications or Drawings as being required to produce the intended result shall be supplied whether or not it is specifically called for, at no additional cost to OWNER.
- d. The Specifications may describe or the Drawings may show the general arrangement of an item of material or equipment when the actual details of said arrangement will vary with the source of the material or equipment. In such cases, CONTRACTOR shall bear all direct and indirect costs to accommodate the item of material or equipment furnished, whether the item of material or equipment is furnished by a manufacturer named in the Specifications or is furnished as an approved substitute or "or equal" item of material or equipment.
- e. Reference to standard specifications, manuals or codes of any technical society, organization or association, or to the code of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual or code in effect at the time of opening Bids. However, no provision of any referenced standard specification, manual or code (whether or not specifically incorporated by reference in the Contract Documents) shall change the duties and responsibilities of OWNER, CONTRACTOR or any of their agents or employees from those set forth in the Contract Documents.
- f. The Contract Documents will be governed by the law of the place of the Project.

B) Re-use of Documents:

Neither CONTRACTOR nor any Subcontractor, manufacturer, fabricator, supplier or distributor shall have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents.

ARTICLE 4 – not used

ARTICLE 5 - BONDS AND INSURANCE – reference contract documents

ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

A) Supervision and Superintendence:

- a. CONTRACTOR shall supervise and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of

construction. CONTRACTOR shall be responsible to see that the finished Work complies accurately with the Contract Documents.

- b. CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, who shall not be replaced without written notice to OWNER except under extraordinary circumstances. The superintendent will be CONTRACTOR'S representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

B) Labor, Materials and Equipment:

CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the site. Except in connection with the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Supplementary Conditions, all Work at the site shall be performed during regular working hours. CONTRACTOR shall advise OWNER when work is planned for Saturday, Sunday or any legal holiday.

CONTRACTOR shall furnish all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances and all other facilities and incidentals necessary for the execution, testing initial operation and completion of the Work

All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by OWNER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind of materials and equipments.

All materials and equipment shall be applied, installed, connected, erected, used cleaned and conditioned in accordance with the instructions of the applicable manufacturer, fabricator, supplier or distributor, except as otherwise provided in the Contract Documents.

A) Substitutions:

Whenever materials or equipment are specified or described in the Drawings or Specifications by using the name of a proprietary item or the name of a particular manufacturer, fabricator, supplier or distributor, the naming of the item is intended to establish the type, function and quality required. The procedure for review by OWNER will be as set forth in Paragraphs 6.3.A.1 below and as supplemented in the General Requirements.

A) Requests for review of substitute items of material and equipment will not be accepted by OWNER from anyone other than CONTRACTOR. If CONTRACTOR wishes to furnish or use a substitute item of material or equipment, CONTRACTOR shall make written application to OWNER for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified.

B) Concerning Subcontractors:

CONTRACTOR shall not employ any Subcontractor or other person or organization (including those who are to furnish the principal items of materials or equipment), whether initially or as a substitute, against whom OWNER may have reasonable objection. A Subcontractor or other person or organization identified in writing to OWNER by CONTRACTOR prior to the Notice of Award and not objected to in writing by OWNER prior to the Notice of Award will be deemed acceptable to OWNER.

CONTRACTOR shall be fully responsible for all acts and omissions of his subcontractors and of persons and organizations directly or indirectly employed by them.

The Divisions and Sections of the Specifications and the identifications of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or delineating the Work to be performed by any specific trade.

All Work performed for CONTRACTOR by a Subcontractor will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor which specifically binds the Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of OWNER.

A) Patent Fees and Royalties:

CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others.

A) Permits

Unless otherwise indicated in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary to complete the Work, which are applicable at the time of opening of Bid. CONTRACTOR shall also pay all charges of utility service companies for connections to the Work.

A) Laws and Regulations:

CONTRACTOR shall give all notices and comply with all laws, ordinances, rules and regulations applicable to the Work. Except where otherwise expressly required by applicable laws, ordinances, rules and regulations, OWNER shall be responsible for monitoring CONTRACTOR'S compliance with any laws, ordinances, rules or regulations.

If CONTRACTOR observes that the Specifications or Drawings are at variance with any laws, ordinances, rules and regulations, CONTRACTOR shall give OWNER prompt written notice thereof, and any necessary changes shall be adjusted by an appropriate Modification.

A) Taxes

CONTRACTOR shall pay all sales, consumer, use and other similar taxes required to be paid by him in accordance with the law of the place of the Project.

A) Use of Premises:

CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workmen to areas permitted by law, ordinances, permits, or the requirements of the Contract Documents, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment.

During progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the site clean and ready for occupancy by OWNER. CONTRACTOR shall restore to their original condition those portions of the site not designated for alteration by the Contract Documents.

CONTRACTOR shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall CONTRACTOR subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

A) Record Documents

CONTRACTOR shall keep one record copy of all Specifications, Drawings, Addenda, Modifications, Shop Drawings and Samples at the site in good order and annotated to show all changes made during the construction process. These shall be available to OWNER for examination and shall be delivered to OWNER upon completion of the Work.

A) Safety and Protection:

CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the safety of, and shall provide the necessary protection to prevent damage, injury or loss.

CONTRACTOR shall comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

Safety Representative:

- A)** CONTRACTOR shall designate a qualified and experienced safety representative at the site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

Hazardous Communication Programs:

- A)** CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the site in accordance with laws, ordinances, rules, or regulations.

B) Shop Drawings and Samples:

After checking and verifying all field measurements, CONTRACTOR shall submit to OWNER for review and approval, in accordance with the accepted schedule of Shop Drawing submissions (see Paragraph 2.6) and the procedures specified in the General Requirements, copies of all Shop Drawings, which shall have been checked by and stamped with the approval of CONTRACTOR and identified as OWNER may require. The data shown on the Shop Drawings will be complete with respect to dimensions, design criteria, materials of construction and the like to enable OWNER to review the information as required.

Contractor shall also submit to OWNER for review and approval with such promptness as to cause no delay in Work, all Samples required by the Contract Documents.

At the time of each submission, CONTRACTOR shall in writing call OWNER's attention to all deviations that the Shop Drawings or samples may have from the requirements of the Contract Documents.

OWNER will review and approve with reasonable promptness Shop Drawings and Samples, but OWNER'S review and approval shall be only for conformance with the design concept of the project and for compliance given with the information given in the Contract Documents and shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.

Where a Shop Drawing or Sample is required by the Specifications, no related Work shall be commenced until the submittal has been reviewed and approved by OWNER.

OWNER'S review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any deviations from the Contract Documents.

A) Continuing the work:

CONTRACTOR shall carry on the work and maintain the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements.

A) N/A

ARTICLE 7 - WORK BY OTHERS

- A) OWNER may perform additional work related to the Project by himself or have additional work performed by utility service companies, or let other direct contracts therefore which shall contain General Conditions similar to these.
- B) N/A
- C) CONTRACTOR shall do all cutting, fitting and patching of his Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of OWNER and the others whose work will be affected.
- D) If the performance of additional work by other contractors or utility service companies or OWNER was not noted in the Contract Documents, written notice thereof shall be given to CONTRACTOR prior to starting any such additional work.

ARTICLE 8 - not used

ARTICLE 9 – not used

ARTICLE 10 - CHANGES IN THE WORK

- A) Without invalidating the Agreement and without notice to any surety OWNER may at any time or from time to time, order additions, deletions or revisions in the Work; these will be authorized by Change Orders. If any Change Order causes an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, an equitable adjustment will be made .
- B) OWNER may authorize minor changes in the Work not involving an adjustment in the Contract Price or the Contract Time which are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order. If CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or Contract Time, CONTRACTOR may make a claim therefor as provided in Article 11 or Article 12.
- C) Additional Work performed without authorization of a Change Order will not entitle CONTRACTOR to an increase in the Contract Price or an extension of the Contract Time.

ARTICLE 11 - CHANGE OF CONTRACT PRICE

- A) The Contract Price Constitutes the total compensation (subject to authorized adjustments payable to CONTRACTOR for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at his expense without change in the Contract Price.
- B) The Contract Price may only be changed by a Change Order. Any claim for an increase in the Contract Price shall be based on written notice delivered to OWNER within five days of the occurrence of the event giving rise to the claim. **Change orders not exceed 10% O&P or state for GC to obtain a mutually acceptable fixed fee with the VIOC PM**
- C) The value of any Work covered by a Change Order or of any claim for an increase or decrease in the Contract Price will be determined as follows:

- a. Where the work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved.
- b. Where the Work involved is not covered by unit prices contained in the Contract Documents, by mutual acceptance of a lump sum.
- c. Where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under Paragraph 11.3.B, on the basis of the Cost of the Work (determined as provided in Paragraph 11.4) plus a Contractor's Fee for overhead and profit (determined as provided in Paragraph 11.5).
- d. Whenever the cost of any Work is to be determined pursuant to Paragraphs 11.4.A and 11.4.B, CONTRACTOR will submit in form acceptable to OWNER, an itemized cost breakdown together with supporting data.

D) Cost of Work:

The term Cost of the Work shall not include any of the following:

- A)** Payroll costs and other compensation of CONTRACTOR'S officers, executives, principals (of partnership and sole proprietorships), general managers, engineers, architects, estimators, lawyers, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR.

B) Contractor's Fee:

The Contractor's Fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:

- A)** A mutually acceptable fixed fee;
- B)** If a fixed fee cannot be agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
- i) For costs incurred under Paragraphs 11.4.A.1 and 11.4.A.2, the Contractor's Fee shall not exceed a total of fifteen percent (for overhead and for profit).
 - ii) N/A
 - iii) No fee shall be payable on the basis of costs itemized under Paragraphs 11.4.A.4, 11.4.A.5 and 11.4.B.
 - iv) The amount of credit to be allowed by CONTRACTOR to OWNER for any such change which results in a net decrease in cost, will be the amount of the net decrease plus a deduction in Contractor's Fee by an amount equal to ten percent of the net decrease.
 - v) When both additions and credits are involved in any one change, the adjustment in Contractor's Fee shall be computed on the basis of the net change in accordance with Paragraphs 11.5.A.2.a through 11.5.A.2.d, inclusive.

C) N/A

N/A

A) Unit Price Work:

Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit prices for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

ARTICLE 12 - CHANGE OF THE CONTRACT TIME – reference contract documents.

ARTICLE 13 - WARRANTY AND GUARANTEE; TESTS AND INSPECTION; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

A) Warranty and Guarantee:

- a. CONTRACTOR warrants and guarantees to OWNER that all Work will be in accordance with the Contract Documents and will not be defective. Reasonably prompt notice of all defects after discovery shall be given to CONTRACTOR. All defective Work, whether or not in place, may be rejected or corrected as provided in this Article 13. General Contractor's shall provide the Owner with a warranty for all labor and materials provided by him and his subcontractors for a period of one (1) year from the project substantial completion date as set forth in the 100% inspection report. This warranty shall include the cost of all labor and materials requested to correct defects in materials and workmanship for the period specified.

B) Access to Work:

OWNER and OWNER'S representatives testing agencies and governmental agencies with jurisdictional interests will have access to the Work at reasonable time for their observation, inspection and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR'S site safety procedures and programs so that they may comply therewith as applicable.

If any law, ordinance, rule, regulation, code or orders of any public body having jurisdiction requires any Work (or part thereof) to specifically be inspected, tested or approved, OWNER (unless another party is specified in the General Requirements) shall assume full responsibility therefor, pay all costs in connection therewith and furnish the required certificates of inspection, testing or approval. CONTRACTOR shall also be responsible for and shall pay all costs in connection with any inspection or testing required by the Specifications in connection with OWNER'S acceptance of a manufacturer, fabricator, supplier or distributor of materials or equipment proposed to be incorporated in the Work, or of materials or equipment submitted for approval prior to CONTRACTOR'S purchase thereof for incorporation in the Work. The cost of all other inspections, tests and approvals required by the Contract Documents shall be paid by OWNER (unless otherwise specified).

All inspections, tests or approvals other than those required by law, ordinance, rule, regulation, code or order of any public body having jurisdiction shall be performed by organizations acceptable to OWNER.

If any Work that is to be inspected, tested or approved is covered without written concurrence of OWNER, it must, if requested by OWNER, be uncovered for observation. Such uncovering shall be at CONTRACTOR'S expense unless CONTRACTOR has given OWNER timely notice of CONTRACTOR'S intention to cover such Work and OWNER has not acted with reasonable promptness in response to such notice.

Neither observations by OWNER nor inspections, tests or approvals by others shall relieve CONTRACTOR from his obligations to perform the Work in accordance with the Contract Documents.

A) Uncovering Work:

If any Work is covered contrary to the written request of OWNER, it must, if requested by OWNER be uncovered for OWNER'S observation and replaced at CONTRACTOR'S expense.

A) Owner May Stop the Work:

If the Work is defective, or CONTRACTOR fails to supply sufficient skilled workers or suitable materials or equipment, or fails to finish or perform the Work in such a way that the completed Work will conform to the Contract Documents, OWNER may order CONTRACTOR to stop the Work.

A) Correction or Removal of Defective Work:

If required by OWNER, CONTRACTOR shall promptly, without cost to OWNER and as specified by OWNER, either correct any defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by OWNER, remove it from the site and replace it with non-defective Work.

A) Warranty Inspection

Warranty Inspection: Approximately ten (10) months following the project substantial completion date the OWNER will perform a warranty inspection. During inspection a warranty inspection report will be compiled listing all items found to be defective as a result of inferior materials and/or workmanship (exclusive of normal wear and tear or obvious abuse) from initial construction. The CONTRACTOR will be notified, in writing, of such defects.

A) One Year Correction Period:

If, within one year after the date of Substantial Completion or such longer period of time as may be prescribed by law or by the terms of any applicable special guarantee required by the Contract Documents, any Work is found to be defective, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER'S written instructions either correct such defective Work or, if it has been rejected by OWNER, remove it from the site and replace it with non-defective Work. CONTRACTOR shall make corrections to defective work within 30 calendar days of notification by OWNER. If the CONTRACTOR does not comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the defective Work corrected or the rejected Work removed and replaced, and all direct and indirect costs of such removal and replacement, including compensation for additional professional services, shall be paid by CONTRACTOR.

ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

A) Schedules

B) Application for Progress Payment

C) Contractor's Warranty of Title:

- a. CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any application for Payment, whether incorporated in the Project or not, will pass to OWNER at the time of payment free and clear of all liens, claims, security interests and encumbrances (hereafter in these General Conditions referred to as "Liens").

D) Review of Applications for Progress Payments

E) Substantial Completion

F) Partial Utilization:

Use by OWNER of completed portions of the Work may be accomplished prior to Substantial Completion of all the Work subject to the following:

- A)** OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any part of the Work which OWNER believes to be substantially complete.
- B)** In lieu of the issuance of a Certificate of Substantial Completion as to part of the Work, OWNER may take over operation of a facility constituting part of the Work whether or not it is substantially complete if such facility is functionally and separately usable.

C) Final Inspection

Upon written notice from CONTRACTOR that the Work is complete, ENGINEER will make a final inspection with OWNER and contractor and will notify CONTRACTOR in writing of all particulars in which this inspection reveals that the Work is incomplete or defective. CONTRACTOR shall immediately take such measures as are necessary to remedy such deficiencies.

ARTICLE 15 – not used

ARTICLE 16 - not used

ARTICLE 17 – not used

SECTION 01091 - REFERENCE STANDARDS**1.0 GENERAL****1.01 SCOPE**

- A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:
- 1) American Association of State Highway and Transportation Officials
 - 2) American Concrete Institute.
 - 3) American Gear Manufacturers Association.
 - 4) American Institute of Steel Construction.
 - 5) American Iron and Steel Institute.
 - 6) American National Standards Institute.
 - 7) American Society of Heating, Refrigerating and Air Conditioning Engineers.
 - 8) American Society of Mechanical Engineers.
 - 9) American Society for Testing and Materials.
 - 10) American Water Works Association.
 - 11) American Welding Society.
 - 12) Concrete Reinforcing Steel Institute.
 - 13) Factory Mutual Association.
 - 14) Institute of Electrical and Electronics Engineers.
 - 15) National Electrical Manufacturer's Association.
 - 16) Occupational Safety and Health Act.
 - 17) National Fire Protection Association.
 - 18) Prestressed Concrete Institute.
 - 19) Underwriters' Laboratories, Inc.
 - 20) New Jersey Administrative Code.
 - 21) Uniform Constructive Code.
 - 22) Building Officials and Code Administration.
 - 23) All other applicable standards listed in the Specifications, and the standards of utility service companies, where applicable.

SECTION 01092 - ABBREVIATIONS AND SYMBOLS**1.0 ABBREVIATIONS**

A. Common abbreviations which may be found in the Specifications are:

alternating current	a-c	maximum	max
ante meridian	a.m.	mercury	Hg
ampere	A	milligram	mg
average	avg	milligrams per liter	mg/l
		milliliter	ml
biochemical oxygen demand	BOD	millimeter	mm
brake horsepower	bhp	million gallon	mil
British thermal unit	BTu	million gallons per day	mgd
		minimum	min
Centigrade	C	net positive suction head	npsh
company	Co	number	no.
cubic inch	cu in	National Pipe Threads	NPT
cubic foot	cu ft		
cubic yard	cu yd	ounce	oz
cubic feet per minute	cfm		
cubic feet per second	cfs		
outside diameter	OD		
decibel	db	parts per million	ppm
degree Centigrade (or Celsius) (say) 20 C		plus or minus	(±)
degree Fahrenheit (say) 68 F		post meridian	p.m.
diameter	diam	pound	lb
direct current	d-c	pounds per square foot	psf
dollars	\$	pounds per square inch	psi
		pounds per square inch absolute	psia
each	ea		
efficiency	eff		
pounds per square inch gage	psig		
Fahrenheit	F	revolutions per minute	rpm
feet	ft		
feet per hour	fph		
feet per minute	fpm	second	sec
feet per second	fps	specific gravity	sp gr
figure	Fig.	square	sq
flange	flg	square foot	sq ft
foot-pound	ft-lb	square inch	sq in
square yard	sq yd		
gallon	gal	standard	std
gallons per minute	gpm	standard cubic feet per minute	scfm
gallons per second	gps		
gram	g		
Hertz	Hz	total dynamic head	TDC
hour	hr	totally-enclosed-	tefc
horsepower	hp		

		fan-cooled	
inch	in.	volt	V
inch-pound	in.-lb		
inside diameter	ID	microgram/kilogram	ug/kg
Action level guideline	ALG		
kilovolt-ampere	kva	parts per billion	ppb
kilowatt	kw		
kilowatt-hour	kwh		
linear foot	lin ft		
liter	l		

2.0 ORGANIZATION ABBREVIATIONS

A. Abbreviations of organizations which may be used in these Specifications are:

ACS	American Chemical Society
ACI	American Concrete Institute
AGMA	American Gear Manufacturers Association
AIChE	American Institute of Chemical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
APHA	American Public Health Association
AREA	American Railway Engineering Association
ASTM	American Society for Testing and Materials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
AWWA	American Water Works Association
AWS	American Welding Society
BOCA	Building Officials and Code Administration
DIPRA	Ductile Iron Pipe Research Association
CRSI	Concrete Reinforcing Steel Institute
ECRA	Environmental Cleanup Responsibility Act
EPA	Environmental Protection Agency
FM	Factory Mutual
HEW	Department of Health, Education and Welfare
HUD	Department of Housing and Urban Development
IEEE	Institute of Electrical and Electronic Engineers
IRI	Industrial Risk Insurance
ISO	Insurance Services Office
NAAMM	National Association of Architectural Metal Manufacturers
NARUC	National Association of Railroad and Utilities Commissioners
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NJAC	New Jersey Administrative Code
NJDEPE	New Jersey Department of Environmental Protection and Energy
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Act
PCI	Precast Concrete Institute
SMACNA	Sheet Metal and Air Conditioning National Association
SSPC	Steel Structures Painting Council
UCC	Uniform Construction Code

UL	Underwriters Laboratories, Inc.
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USPHS	United States Public Health Service
WWEMA	Water and Wastewater Equipment Manufacturers Association
WPCF	Water Pollution Control Federation

3.0 LEGEND

- A. Legends of symbols used are shown on the Drawings, and in general, use of symbols is confined to the Drawings.

SECTION 01220 - PROGRESS MEETINGS

1.0 GENERAL

1.01 SCOPE

- A. Date and Time:
 - 1) Regular Meetings: As mutually agreed upon by OWNER and CONTRACTOR.
 - 2) Other Meetings: On call.
- B. Place: OWNER'S office at Project site or other mutually agreed upon location.
- C. OWNER shall prepare agenda, preside at meetings, and prepare and distribute a transcript of proceedings to all parties.
- D. CONTRACTOR shall provide data required and be prepared to discuss all items on agenda.

1.02 MINIMUM ATTENDANCE

- A. CONTRACTOR:
 - 1) When needed for the discussion of a particular agenda item, CONTRACTOR shall require representatives of Subcontractors or suppliers to attend meeting
- B. OWNER'S representative, if required.
- C. Others as appropriate.
- D. Representatives present for each party shall be authorized to act on their behalf.

1.03 AGENDA

- A. Agenda may include, but will not necessarily be limited to, the following:
 - 1) Transcript of previous meeting.
 - 2) Progress since last meeting.
 - 3) Planned progress for next period.
 - 4) Problems, conflicts and observations.
 - 5) Change Orders.
 - 6) Status of Shop Drawings.
 - 7) Quality standards and control.
 - 8) Schedules, including off-site fabrication and delivery schedules. Corrective measures, if required.
 - 9) Coordination between parties.
 - 10) Safety concerns.
 - 11) Other Business.

SECTION 01340 - SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

1.0 GENERAL

1.01 SUBMITTALS

- A. Submit shop drawings, product data and samples required by Contract Documents, within 30 days after award of the Contract.
- B. Shop drawings and/or manufacturer's product data submittals are required if the product or useage is different from that specified in the drawings. Submit four (4) copies to OWNER's representative for review and written approval. Do not proceed without OWNER approval.

1.02 SHOP DRAWINGS

- A. Drawings shall be presented in a clear and thorough manner. Details shall be identified by reference to sheet and detail, schedule or room number shown on Contract Drawings. Provide reinforcing steel details, and structural steel shop drawings. Field measure all members to assure match to existing building.

1.03 SAMPLES

- A. Office samples shall be of sufficient size and quantity to clearly illustrate functional characteristics of the product, with integrally related parts and attachment devices and the full range of color, texture and pattern.

SECTION 01341 - PROJECT COORDINATION

1.0 GENERAL

- A. As more fully set forth in Article 6 of the General Conditions, CONTRACTOR shall be solely responsible for coordination of all of the Work. He shall supervise, direct and cooperate fully with all Subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the Work within the Contract Time. Each subcontractor shall be responsible to coordinate their work activity directly through the CONTRACTOR and with other trades not the OWNER.
- B. As more fully set forth in Article 7 of the General Conditions, CONTRACTOR shall cooperate with and coordinate his Work with the work of any other contractor, utility service company or OWNER'S employees performing additional work related to the Project at the site.
- C. CONTRACTOR shall not be responsible for damage done by contractors not under his jurisdiction. He will not be liable for any such loss or damage unless it is through the negligence of the CONTRACTOR.
- D. CONTRACTOR shall maintain sufficient competent personnel and supplies at the site for the purpose of preparing AS-BUILT drawings. The CONTRACTOR will ensure that each Subcontractor maintains AS-BUILT information pertinent to their specific work.
- E. CONTRACTOR shall also coordinate his Work with the work of others identified in Section 1A1, Article 1.3, to assure compliance with schedules.
- F. CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all Work and compliance with schedules.
- G. CONTRACTOR shall prepare and submit for OWNER review and approval all waste disposal applications, land ban notices, manifests, and associated transportation and disposal applications at least two (2) weeks prior to transportation of any waste materials off-site.
- H. CONTRACTOR shall coordinate all site work, transportation, and disposal activities to minimize downtime.

SECTION 01410 - INSPECTION, SAMPLING AND TESTING LABORATORY SERVICES

1.0 GENERAL

- A. The CONTRACTOR will employ and pay for an independent testing laboratory to perform the specified inspection, sampling and testing services. These include:
- 1) Soils Compaction, Division 31.
 - 2) Paving and Surfacing, Division 32.
 - 3) Concrete, Divisions 3 & 32.
- B. The testing laboratory is not authorized to approve or accept any portion of the Work; rescind, alter or augment the requirements of the Contract Documents; or perform any duties of the CONTRACTOR.

1.01 QUALIFICATIONS OF LABORATORY

- A. Where applicable, the testing laboratory will meet "Recommended Requirements for Independent Laboratory Qualification", latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E 329 "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction".

1.02 LABORATORY DUTIES

- A. Where applicable, the testing laboratory will:
- 1) Cooperate with OWNER and CONTRACTOR and provide qualified personnel promptly on notice.
 - 2) Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; ascertain compliance with requirements of Contract Documents.
 - 3) Promptly notify OWNER and CONTRACTOR of irregularities or deficiencies of Work which are observed during performance of services.
 - 4) Promptly submit 5 copies of reports of inspections and tests to OWNER, including:
 - a) Date issued.
 - b) Project title and number.
 - c) Testing laboratory name and address.
 - d) Date of inspection or sampling.
 - e) Record of temperature and weather.
 - f) Date of test.
 - g) Identification of product and Specification Section
 - h) Location in Project.
 - i) Type of inspection or test.
 - j) Results of tests and observations regarding compliance with Contract Documents.
 - 5) Perform additional tests and services as required by OWNER.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The CONTRACTOR shall:
- 1) Cooperate with laboratory personnel, provide access to Work and to manufacturer's operations.
 - 2) Provide to laboratory, preliminary representative samples of materials to be tested, in required quantities.
 - 3) Furnish copies of product test reports.
 - 4) Provide to the laboratory the preliminary design mix proposed for concrete, and other material mixes that require testing by the testing laboratory.
 - 5) Furnish labor and facilities:
 - a) To provide access to Work to be tested.
 - b) To obtain and handle samples at the site.
 - c) To facilitate inspections and tests.

- d) For laboratory's exclusive use for storage and curing of test samples.
- e) Forms for preparing concrete test beams and cylinders.
- 6) CONTRACTOR shall coordinate testing with OWNER. Notify laboratory and OWNER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.
- 7) Arrange with laboratory and pay for, additional samples and tests required for CONTRACTOR'S convenience.

1.04 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Payment for these services will be paid by Owner.
 - 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 - 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - 5. Submit copies of each written report directly to authorities having jurisdiction, when directed.
- C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- E. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - 1. Notify Owner and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.

3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
- F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.05 SPECIAL TESTS / INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
- B. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Owner and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Owner with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work.

1.06 REPAIR / PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
 2. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."
- B. Protect construction exposed by or for quality-control service activities.

- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

SECTION 01500 – TEMPORARY UTILITY SERVICES**1.0 GENERAL**

- 1.01 Utility Cost: The General Contractor shall include in the contract sum the cost of all utility services required for the project until the project final completion date as set forth in the 100% Final Inspection Report.
- 1.02 Provide the required temporary utility services to the project as set forth in these specifications and in compliance with all governing local codes and ordinances.
- 1.03 Provide potable water to the project for drinking and construction purposes from local/municipal service or other as applicable.
- 1.04 Temporary Heat: Where permanent mechanical systems are not yet operable, provide self-contained LP gas, fuel oil, or kerosene space heaters to maintain a temperature of 45 degrees F in the enclosed building. Provide adequate ventilation in these spaces.
- 1.05 Temporary Electrical: Provide a weatherproof, grounded electrical service as required until the building electrical operable.
- 1.06 Temporary Lighting: Provide temporary lighting of sufficient intensity and quality for the proper and safe performance of the work.
- 1.07 Temporary Sanitary Facilities: Provide temporary single occupant, self-contained toilet facilities in compliance with local regulations.
- 1.08 Temporary Telephone Service: Provide a minimum of one temporary telephone at project site with fax capability throughout construction. Notify the Owner's Representative of the telephone number/s as soon as service is connected.
- 1.09 Dewatering/Site Drainage: Maintain the project site construction work free of water accumulation and protect against flooding, "Do not endanger the work or adjacent properties."
- 1.10 Construction Debris: Collect and containerize all construction debris daily. Remove from project site as required and in compliance with local ordinances.

SECTION 01540 - PROJECT SECURITY & PROTECTION**GENERAL**

1.1. The Contractor shall be responsible for all violations of city codes, ordinances, and state laws involved in the performance of his Work; and for obstruction of streets, sidewalks, alleys, and pavements, and shall in all cases make good any damage to any streets, sidewalks, alleys and pavements. He shall use every precaution to brace and otherwise support and secure the structural frame, walls, floors and roof during the construction of the work; and shall provide, during the progress of his work, every and all safeguards and protection against accidents, injury and damage to persons and property including adjoining property. The Contractor shall be responsible for his work and every part thereof, and for all materials, tools, appliances and property of every description used in connection therewith.

1.2. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, water ways, and subsoil might be contaminated or polluted or that other undesirable effects might result. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-producing tools and equipment to hours that will minimize complaints from persons or firms near the site. The Contractor shall not use any fill or other materials to be incorporated into the Work that contain asbestos, are hazardous, toxic or are made up of materials that are hazardous or toxic materials as defined from time to time by applicable federal or state laws, rules, and regulations.

1.3. Security Enclosure and Lockup: Install substantial temporary enclosure of partially completed areas of construction. Provide locking entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

1.4. Enclosure Fence (if required): Before excavation begins, install an enclosure fence with lockable entrance gates. Locate where indicated, or enclose the entire site or the portion determined sufficient to accommodate construction operations. Install in a manner that will prevent people, dogs, and other animals from easily entering the site, except by the entrance gates.

1.5. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erection of structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and the public of the hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

1.6. Temporary Fire Protection: Until fire protection needs are supplied by permanent facilities, install and maintain temporary fire protection facilities of the types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA

1. Locate fire extinguishers where convenient and effective for their intended purpose.
2. Store combustible materials in containers in fire-safe locations.
3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.
4. Provide supervision of welding operations, combustion-type temporary heating units, and similar sources of fire ignition.

1.7. HOT WORK: Where Work involves the use of flame, spark or hot ember producing equipment, such as but not limited to, welding, blow torches and metal grinding type equipment and equipment using internal combustion engines ("Hot Work"). In order to prevent the potential for fires, Hot Work safety procedures must be followed that include, but shall not be limited to, the following elements: Pre-work inspection of the area to identify and minimize the presence of combustible or flammable materials, the use of flame resistant building surface coverings such as welding blankets and fire retardant tarpaulins (tarps), in the area of hot work, damping down the area, the presence of a functional dry chemical fire extinguisher with a minimum rating of 10B-C within 10 feet of the Hot Work area, and post-work inspection of the area for any signs of smoldering or burning materials and extinguishment of these materials. The Hot Work procedures will also highlight the need for extra caution for hot work in areas on the roof, near ventilation exhaust systems. These Hot Work procedures will be planned for, initiated and monitored through the use of written Hot Work permit, which will be signed by both the designated job site superintendent and the person performing the hot work. The Hot Work permit shall be posted in the work area and a copy provided to OWNER if requested.

SECTION 01610 - DELIVERY, STORAGE AND HANDLING

PART 1- GENERAL

- 1.01. Owner Supplied Equipment: The General Contractor shall be responsible for the receipt and storage of all materials and equipment, including owner supplied equipment. If the building is not complete at such time, the contractor shall provide proper storage facilities so as to prevent theft or damage to the equipment. Notify Owner promptly of any equipment that arrives damaged or is found to be defective
- 2.01. The General Contractor shall be responsible for the complete assembly and installation of all Owner supplied equipment as shown in the drawings, unless otherwise specifically stated. Final electrical and plumbing connections to said equipment shall be as stated in the applicable sections of the technical specifications.

SECTION 01700 – PROJECT CLOSEOUT**PART 1- GENERAL**

- 1.01. Record Documentation: Maintain the following for submittal to the Owner's Representative as set forth herein.
- 2.01. Record Drawings: Maintain a complete set of blue-line prints of contract drawings and shop drawings for record mark-up purposes throughout the contract time. Mark-up drawings during the course of the work to show changes and actual installation conditions, sufficient to serve as a complete record for Owner's purposes. Give particular attention to work which will be concealed and difficult to measure and record at a later date. General Contractor to provide a CD with scanned electronic images (PDFS) of completed marked up as built contract and shop drawings at the end of the project.
- 3.01. Maintenance Manuals: Provide 3-ring vinyl covered binder(s) containing required maintenance manuals, properly identified and indexed. Include operating and maintenance instructions; extended to cover emergencies, spare parts, warranties, inspection procedure diagrams, safety, security, and similar appropriate data for each system or equipment item.
- 4.01. Final Cleaning: Immediately prior to the date at the Final 100% Inspection: remove non-permanent protection and labels, polish glass, clean or replace filters of mechanical system, remove debris and thoroughly clean and mop facilities, clean light fixtures and replace burned-out / dimmed lamps, sweep and pressure wash paved areas, police yards and grounds, perform similar clean up operations needed to produce a "clean" condition as judged by Owner's Representative.
- 5.01. Procedures for Final Inspection
 - a. Prerequisites: Comply with General conditions and complete the following before requesting the 100% Final Inspection for the work:
 - b. Submit executed warranties, workmanship bonds, maintenance agreements, inspection certificates and similar required certificates and similar required documentation for specific units of work enabling Owner's unrestricted occupancy and use.
 - c. Submit record documentation, main keys and similar operational items.
 - d. Complete instruction of Owner's operating personnel, and start up of systems.
 - e. Prepare a list containing the General Contractor's and all of his subcontractor's names, address, and phone numbers for the project. Give a copy of the list to the Owner's Representative and to the Instant Oil Change store manager.
 - f. Final inspection: After all prerequisites have been fulfilled, the General Contractor shall notify the Owner's Representative that the building is ready for Final Inspection.

SECTION 02060 - DEMOLITION**PART 1- GENERAL****1.01 SECTION INCLUDES**

- A. Demolition of existing buildings and site improvements
- B. Demolition of existing on-grade materials.
- C. Removal of below-grade construction (ie. underground storage tanks and related piping, footers, etc.)
- D. Removal of resulting debris.

1.02 RELATED SECTIONS

- A. Section 02110 - Site Clearing.
- B. Division 31 - Earthwork: For filling of voids caused by demolition.

1.03 QUALITY ASSURANCE

- A. Comply with all laws, rules and regulations of governmental authorities having jurisdiction over the demolition work.
- B. Provide protection for all persons and property in accordance with ANSI/NFPA 241-89 Safeguarding Building Construction and Demolition Operations.
- C. Obtain and pay for all permits and licenses.
- D. Provide rodent control as required.
- E. Conform to applicable codes for disposal of rubbish, tires, environmental hazardous waste and contaminated soils.
- F. Underground storage tanks and piping removal by licensed and/or certified contractors only.
- G. Comply with all regulatory procedures for UST removal.

1.04 PROJECT CONDITIONS

- A. Occupancy: Structures to be demolished will be vacated and discontinued in use prior to start of work.
- B. Condition of Structures: Owner assumes no responsibility for actual condition of structures to be demolished.
- C. Explosives: Use of explosives will not be permitted.
- D. Traffic: Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walks, and other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- E. Protection: Ensure safe passage of persons around area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities, and persons.
- F. Utility Services: Protect and maintain existing utility lines which are to remain in service to avoid interruption of these lines. Cap utility lines terminated by the demolition work in a manner approved by the governmental authorities and utility companies having jurisdiction.
- G. Fire Prevention: Perform the demolition work to prevent fires. Remove debris promptly. No materials shall be burned on the site.
- H. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.

1.05 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.06 SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
 - 1. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
- C. Schedule of Building Demolition Activities: Indicate the following:
 - 1. Detailed sequence of demolition work, with starting and ending dates for each activity.
 - 2. Temporary interruption of utility services.
 - 3. Shutoff and capping or re-routing of utility services.
- D. Predemolition Photographs: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
- E. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.07 QUALITY ASSURANCE

- A. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 and NFPA 241.
- D. Predemolition Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

- A. Satisfactory Soils: Comply with requirements in Division 31 - Earthwork

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.
- B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

- C. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.
- D. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

3.02 PREPARATION

- A. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
- B. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
 - 1. Arrange to shut off indicated utilities with utility companies.
 - 2. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 - 3. Cut off pipe or conduit a minimum of 24 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.
- C. Existing Utilities: Refer to Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.
- D. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of demolition.
- E. Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Pack or crate items after cleaning. Identify contents of containers.
 - 3. Store items in a secure area until delivery to Owner.
 - 4. Transport items to storage area designated by Owner.
 - 5. Protect items from damage during transport and storage.

3.03 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
 - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction. Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
- C. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated.
 - 1. Protect adjacent buildings and facilities from damage due to demolition activities.
 - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 3. Erect a plainly visible fence around drip line of trees to remain.
 - 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
- D. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

3.04 DEMOLITION

- A. Procedures for removal of any hazardous waste, asbestos, underground tanks or petroleum piping must be reviewed with the Owner's Construction Manager prior to starting any work.
- B. Demolish buildings, paving, walks, and curbs completely and remove from site. Use such methods as required to complete work within limitations of governing regulations.
 1. Demolish and remove below-grade construction including basements.
 2. Wet down all piled materials and materials being discharged into vehicles.
- C. Protect existing landscaping and structures which are not to be demolished.
- D. The concrete floor in the existing basements shall be broken to facilitate the movement of water through it. It may be left in place if broken up, but not otherwise disturbed. Place engineered fill to grade per section 31001.

3.05 DEMOLITION BY MECHANICAL MEANS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
- B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
- C. Below-Grade Construction: Demolish foundation walls and other below-grade construction.
 1. Remove below-grade construction, including basements, foundation walls, and footings, completely.
- D. Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove materials resulting from the demolition work from the site to avoid creating a nuisance. Dispose of materials from the site on a daily basis to locations determined by the Contractor, at no additional cost to the Owner. Take possession of salvageable material and equipment as property of the Contractor and promptly remove from the site. Construction waste materials must be disposed of in an approved landfill.
- B. Waste disposal tickets must be submitted to the construction supervisor if requested.

3.07 REPAIR AND CLEANING

- A. Promptly repair damage to property of the Owner which is to remain in use, or that of any person, or persons on or off the site caused by the demolition work without additional expense to the Owner.
- B. Promptly repair damage to adjacent properties caused by the demolition work without additional expense to the Owner.

- C. Clean adjacent structures and improvements of dust, dirt and debris caused by demolition operations, as directed by Owner's Construction Manager or governing authorities. Return adjacent areas to condition existing prior to start of work.

SECTION 02110 – SITE CLEARING**1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Protection of existing trees and other site improvements designated to remain.
- B. Removal of trees and other vegetation.
- C. Topsoil stripping.
- D. Clearing and grubbing.
- E. Removal of above-grade improvements.
- F. Removal of below-grade improvements.

1.02 RELATED SECTIONS

- A. Section 02060 - Building Demolition
- B. Section 31001 - Earthwork

1.03 QUALITY ASSURANCE

- A. Comply with codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION**3.01 PREPARATION**

- A. Protection of Trees:
 - 1. Protect trees which are indicated on the Drawings to remain and those to be relocated. Material and debris shall not be piled under such trees. Extensive grading shall not be performed under such trees within the spread of the branches. Where trees are inadvertently damaged, damage to such trees shall be repaired by persons skilled in the care of trees. Protection shall be provided at tree drip line.
- B. Location and Protection of Utilities:
 - 1. Call local utility companies for locations prior to commencing.
 - 2. Protect existing service lines and related structures encountered in the clearing work. If damaged, repair such lines and structures or arrange for their repair with the proper authorities or companies.
- C. Protection of Site Improvements:
 - 1. Protect site improvements which are indicated on the Drawings to remain. Restore damaged improvements to their original condition.
- D. Damage to trees, utilities and other site improvements shall be corrected at no additional cost to Owner.
- E. Sediment and Erosion Control:
 - 1. Contractor shall provide hay bales or silt fence along the perimeter of the property or limits of the site clearing when required.
 - 2. Cautionary steps shall be taken to avoid erosion of any soils.

3.02 SITE CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements, and obstructions interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated.
- B. Clearing and Grubbing: Clear site of trees, shrubs and other vegetation, except for those indicated to remain.
 - 1. Completely remove stumps, roots, and other debris.
 - 2. Carefully and cleanly cut roots and branches of trees indicated to remain, where such roots and branches obstruct new construction.
 - 3. Use only hand methods for grubbing inside drip line of trees indicated to remain.
 - 4. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - a. Place fill material in horizontal layers not exceeding 6" loose depth, and thoroughly compact to a density in accordance with section 31001, Earthwork.
- C. Topsoil: Topsoil is defined as surface soil approved by Owners Construction Supervisor found in a depth of not less than 4". Satisfactory topsoil is reasonably free of subsoil, clay, lumps, stones, and other objects over 1 inch in diameter, and without weeds, roots and other objectionable material.
 - 1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil and other objectionable material.
 - a. Remove heavy growths of grass from areas before stripping.
 - b. Where trees are indicated to remain, stop topsoil stripping a sufficient distance to prevent damage to surface root system.
 - 2. Stockpile topsoil in storage piles in areas shown, or where directed. Construct storage piles to freely drain surface water. Cover storage piles if required to prevent wind-blown dust.
 - 3. Dispose of unsuitable and excess topsoil as specified for waste material.
- D. Remove existing on-grade and below-grade construction which may be encountered in areas to be occupied by new construction. In areas of general grading and areas which are to be paved, remove obstructions that may be encountered to a depth of at least 18" below the rough grades.
 - 1. Abandonment or removal of certain underground pipe and conduits may be shown on mechanical or electrical drawings (if any), and is included under work of those sections. Removal of abandoned underground piping and conduit interfering with construction is included under this Section.

3.03 DISPOSAL OF MATERIALS

- A. Burning on Owner's Property: Burning is not permitted on Owner's property.
- B. Removal from Owner's Property: Remove unsuitable and excess topsoil from Owner's property and dispose of in an approved manner.

3.04 DUST CONTROL

- A. Use means necessary to control dust on and near the work if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site as required by applicable codes.
- B. Thoroughly moisten surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.

3.05 TRAFFIC CONTROL

- A. Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities. Do not close or obstruct streets, walks and other occupied and used facilities without permission from authorities having jurisdiction.

- B. Any silt or mud tracked off the property by transporting vehicles shall be immediately removed by the contractor. Care should be taken to avoid any reoccurrence.

SECTION 02330 BENCHMARK AND SURVEY

GENERAL

SCOPE

- A. Prior to start of construction, CONTRACTOR shall confirm the accuracy of the Bench Mark indicated on Owner's drawings. CONTRACTOR shall immediately advise OWNER of any errors or discrepancies.
- B. Prior to start of construction, CONTRACTOR shall confirm the accuracy of property markers Indicated on OWNER's drawings. CONTRACTOR shall immediately advise OWNER of any errors or discrepancies. OWNER shall arrange for any survey corrections. It is the CONTRACTOR'S responsibility to preserve all property pins.

SECTION 03100 – CONCRETE FORMWORK**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Form work for building concrete.
- B. Forms for area lights, sign foundations and miscellaneous yard items.
- C. Form ties and accessories

1.02 RELATED SECTIONS

- A. Section 03200 - Concrete Reinforcement.
- B. Section 03300- Cast-In-Place Concrete.

1.03 QUALITY ASSURANCE

- A. Form work shall comply with "Recommended Practice for Concrete Form work" ACI 347R.
- B. Design criteria/construction tolerances shall comply with ACI 301.
- C. Anchor bolt tolerances shall comply with AISC "Code of Standard Practice" September 1, 1986, Paragraph 7.5.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Wood Form Sheathing:
 - 1. Finish No. 1 (Concealed Below Grade Concrete): 3/4" exterior plywood, B-B Concrete Form Class II, PS-1-83.
 - 2. Finish No. 2 (Exposed concrete): Same as for Finish No. 1.
 - 3. Finish No. 3 (Smooth Concrete): 3/4" exterior type, resin coated plywood, High Density concrete Form Overlay, Class I, PS-1-83.
- B. Chamfer Strips: 3/4" vinyl or wood with or without nailing flange at Contractor's option, No. G22 or 612 (Greenstreak Plastic Products Co.); No. CS-3/4 or CSN-3/4 (Vinylex Corp).
- C. Form Ties: Internal disconnect, or snap type, leaving metal no closer than 1" from surface of concrete or a hole no larger than 3/4" in diameter. Form ties shall be factory fabricated.
- D. Form Coating: A commercial product to facilitate stripping without staining or damaging concrete or impairing future concrete treatment.
- E. Sonotube fiber forms or approved equal may be used below ground when approved by Owner's Construction Manager.
- F. Earth cuts may be used as forms for vertical surfaces of footings when approved by Construction Supervisor.

PART 3 EXECUTION**3.01 CONSTRUCTION DETAILS FOR FORM WORK**

- A. Forms shall be thoroughly cleaned and shall conform to shape, lines and dimensions shown on the drawings, be designed to resist the pressure and weight of the concrete, be properly tied and braced or shored so as to maintain position and shape, and be sufficiently tight to prevent leakage of mortar. Forms shall be designed and constructed to facilitate easy removal without damage to exposed surfaces, and to provide smooth

concrete surfaces free of off-sets. Corners shall be true to lines and profiled as detailed. Form joints which will be exposed to view shall be kept to a minimum and shall be located symmetrically within each modular unit.

- B. Before reinforcing steel is set, wood forms shall be coated with an approved non-staining form oil, or wet with water (Except in freezing weather). Metal forms shall be coated with an approved non-staining rust preventive form oil. Stained forms shall not be used.
- C. Provide temporary openings to facilitate cleaning and inspection immediately before depositing concrete.
- D. Form material is subject to Owner's Construction Manager's approval before construction of forms. Forms for exposed concrete may be reused only if the surfaces have not absorbed moisture and have not splintered, warped, discolored, stained, rusted or peeled, subject to the Owner's Construction Manager's approval.
- E. Exposed corners shall be chamfered unless otherwise shown. Where corners are shown chamfered, wood, polyvinyl chloride or neoprene extruded corner strips shall be inserted in the forms. Corners which abut masonry walls shall not be chamfered.
- F. Place bulkheads where end of days work requires a joint in a concrete member. Reinforcing steel shall extend through the bulkhead. Joints shall be keyed for 1/2 of the member thickness unless otherwise directed. Location of bulkheads on structured or load bearing walls shall be as approved by the Owner's Construction Manager.
- G. Form openings in concrete as shown on the Drawings or required by other trades to accommodate their work. Accurately place and securely support items to be built into forms.
- H. Set and build into the Work the anchorage devices and other imbedded items required for other work that is shown on the Drawings attached to, or supported by, cast-in-place concrete. Coordinate location and placement with other trades.

3.02 FORM REMOVAL

- A. Removal of forms and shoring shall be in accordance with ACI 318.
- B. Exercise special care when removing forms from exposed concrete surfaces.
- C. Results of job-cured cylinders per ASTM C31 shall be used as evidence that concrete has obtained required strength to allow removal of form work.

3.03 RESHORES

- A. Construction loads exceeding the structural design loads shall not be supported upon any unshored portion of the structure.

3.04 TOLERANCES

- A. Forms shall be designed, constructed and maintained, and concrete shall be placed so as to ensure completed concrete work within the tolerance limits set forth in ACI 347R.

3.05 FIELD QUALITY CONTROL

- A. Check the lines and levels of the completed form work before concrete is placed, and make whatever corrections or adjustments to the form work necessary to correct deviations from the specified tolerances.
- B. Check form work during the placement of the concrete to ensure that the forms, shores, tie rods and clamps have not been moved from the established line, level and cross section by concrete pouring methods and equipment.

SECTION 03200 – CONCRETE REINFORCEMENT**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Steel reinforcing bars.
- B. Welded wire fabric.
- C. Accessories.

1.02 RELATED SECTIONS

- A. Section 03100- Concrete Form work.
- B. Section 03300 - Cast-In-Place Concrete.
- C. Section 04200 - Unit Masonry: For reinforcing in masonry walls.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Shop Drawings: Fabrication and placing drawings for reinforcing steel, conforming with the ACI SP-66. Include bar bending diagrams and construction joint locations.

1.04 QUALITY ASSURANCE

- A. The reinforcement work shall conform with the following except when in conflict with the building code in force; in such event the building code will govern.
 - 1. Specifications for Structural Concrete for Buildings, ACI 301.
 - 2. Details and Detailing of Concrete Reinforcement, ACI 315.
 - 3. Building Code Requirements for Reinforced Concrete, ACI 318.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Properly label bars with weatherproof tags to facilitate identification.
- B. Store reinforcing steel on supports above ground level. Keep covered with tarpaulins if there is a delay in use. Immediately remove damaged and otherwise unsuitable material, when so determined, from the site.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. New-Billet Steel Bars: ASTM A615, Grade 60, unless otherwise shown.
 - 1. Comply with ACI 301, Article 5.6.1 and CRSI MSP 1, Chapter 7 for fabrication tolerances. Shop fabricate reinforcing bars using a bending procedure which does not damage steel.

- B. Accessories: Provide bar supports and other accessories necessary to hold bars in proper position while concrete is being placed.
- C. All concrete flatwork shall have 6"x6"xW2.9xW2.9 welded wire fabric (WWF) with 6" laps, unless the drawings call for bar type or heavier reinforcing. The welded wire fabric shall comply with ASTM A1064. Where shown on Drawings, Fibrous concrete reinforcement may be substituted for welded wire fabric. Fibrous concrete reinforcement shall be provided by Fibermesh Company. Use only Fibermesh (MD) with only 100% virgin polypropylene fibrillated fibers containing no reprocessed olefin materials where the concrete is tested in accordance with ASTM C-94 and C-1116.
- D. Smooth dowell bars: ASTM A36

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean reinforcement to remove loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

3.02 INSTALLATION

- A. Place reinforcement according to the approved placement drawings. Use sufficient bar supports, ties, anchors and other accessories to hold bars securely in place.
 - 1. Splice reinforcing bars only where indicated on the Drawings.
 - a. Splices shall be lapped a minimum of 30 bar diameters and tied.
 - 2. Provide sufficient numbers of supports and of strength to carry reinforcement. Do not place reinforcing bars more than 2" beyond the last leg of continuous bar supports. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
 - 3. Where chairs and other accessories are in contact with the form work of exposed concrete, they shall be stainless steel legged, or plastic tipped unless otherwise approved by the Engineer.
- B. Fiber reinforcement shall be added to concrete mix at the time of batching in the amounts of 1 1/2 pounds for cu. ft. of concrete.
- C. Field Adjustments: Adjust bar locations to avoid interference with inserts, sleeves and other reinforcing. When adjustment exceeds 25 percent of spacing within the plane or 1 (one) bar diameter perpendicular to the plane of the reinforcing, the layout shall be reviewed by the Structural Engineer.
 - 1. No bars shall be placed while concrete is being poured.
 - 2. No bars shall be bent after being partially embedded in hardened concrete.
- D. Coordinate and cooperate with other trades to ensure that reinforcing is in proper place and that pipes, sleeves, conduit, anchors, bolts, flashings, caulking grooves, slips and other inserts of other trades to be cast into concrete are securely placed before concrete is placed.

3.03 TOLERANCES

- A. Reinforcing shall be protected by the following minimum thicknesses of concrete, unless otherwise indicated on the Drawings:

Minimum

Cover (In.)

1. Concrete cast against and permanently exposed to earth: 3
2. Concrete exposed to weather
 - a. No. 5 bar or smaller, W31 or D31 wire and smaller 1-1/2
 - b. No. 6 bar and larger 2

SECTION 03300 – CAST-IN-PLACE CONCRETE**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Piers
 - 5. Equipment pads and bases.
- B. Related Sections include the following:
 - 1. Division Section 07210 "Building Thermal Insulation" for perimeter insulation under slabs-on-grade

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
- B. Design Mixtures (if requested by Owner): For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Welding certificates (if requested by Owner).
- D. Qualification Data (if requested by Owner): For Installer and testing agency.
- E. Material Test Reports (if requested by Owner): For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- F. Material Certificates (if requested by Owner): For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Fiber reinforcement. (If shown on Drawings.)
 - 6. Curing compounds.
 - 7. Floor and slab treatments.
 - 8. Bonding agents.
 - 9. Adhesives.
 - 10. Vapor retarders.
 - 11. Semirigid joint filler.
 - 12. Joint-filler strips.
 - 13. Repair materials.

- G. Field quality-control test and inspection reports (if requested by Owner).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 2. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 3. ACI 318, "Building Code Requirements for Structural Concrete."
- F. Concrete: Comply with Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
1. Materials and mixes to perform quality control testing where required by Project Manager in accordance with General Conditions.
 2. Provide the services of a testing laboratory to design concrete mixes.
 3. Testing agency shall meet the requirements of ASTM E329.
 4. Selection of a testing laboratory is subject to the Project Manager's acceptance.
 5. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information as may be requested by the Project Manager.
- H. Tests for Concrete Materials:
1. For normal weight concrete, test aggregates by the methods of sampling and testing of ASTM C33.
 2. For Portland Cement, sample the cement and determine the properties by the methods of test of ASTM C150.
 3. Submit written reports for each material sampled and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not materials are acceptable for intended use.
- J. Certificates of material properties and compliances with specified requirements must be submitted. Certificates of Compliance for proposed batch ingredients and admixtures must be signed by the materials producer and are to be submitted in the submittal.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C 330, 1/2-inch nominal maximum aggregate size.
- E. Water: ASTM C 94 and potable.

2.2 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Retarding Admixture: ASTM C 494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494, Type C.
 - 1. Products:
 - a. Euclid Chemical Company; Eucon CIA.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI.
 - c. Master Builders, Inc.; Rheocrete CNI.
 - d. Sika Corporation; Sika CNI.
- D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - 1. Products:

- a. Cortec Corporation; MCI 2005NS.
- b. Grace Construction Products, W. R. Grace & Co.; DCI-S.
- c. Master Builders, Inc.; Rheocrete 222+.
- d. Sika Corporation; FerroGard-901.

2.3 FIBER REINFORCEMENT

- A. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 3/4 inches long.
 - 1. Products:
 - a. Fibrillated Fibers:
 - 1) SI Concrete Systems; Fibermesh.

2.4 WATER PROOFING MEMBRANE

- A. Refer to Division 07, Sections 07132 and 07133.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.5 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products:
 - a. ChemMasters; Spray-Film.
 - b. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - c. Dayton Superior Corporation; Sure Film.
 - d. Euclid Chemical Company; Eucobar.
 - e. L&M Construction Chemicals, Inc.; E-Con.
 - f. Meadows, W. R., Inc.; Sealtight Evapre.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products:
 - a. ChemMasters; Safe-Cure Clear.
 - b. Conspec Marketing & Manufacturing Co., a Dayton Superior Company; W.B. Resin Cure.
 - c. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - d. Euclid Chemical Company; Kurez DR VOX.
 - e. L&M Construction Chemicals, Inc.; L&M Cure R.
 - f. Meadows, W. R., Inc.; 1100 Clear.
 - g. Tamms Industries, Inc.; Horncure WB 30.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.0217-inch thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.7 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 - 5. Silica Fume: 10 percent.
 - 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 - 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
 - 5. Air-Entrainment – Per ASTM C260.

2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109.

2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Refer to structural drawings and specs in construction documents.

2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 EXECUTION

3.0 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 3. Install dovetail anchor slots in concrete structures as indicated.

3.1 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated, or a maximum of 20 feet. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 - 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.2 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Comply with ACI304, "Guide For Measuring, Mixing, Transporting and Placing Concrete," and as specified.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Owner's Representative

- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces uniformly to drains where required.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed-water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- H. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.3 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
 - 1. Apply to concrete surfaces exposed to public view, to be covered with a coating or covering material applied directly to concrete.

- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.4 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
 - 1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings
- C. Trowel Finish: Interior slabs only. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated, exposed to view or to be covered with ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 - 2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Owner's Representative before application.

3.5 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.6 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and

- during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
 - D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
 - E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.7 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.8 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Owner. Remove and replace concrete that cannot be repaired and patched to Owner's approval.

- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalling, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Owner's representative.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - 2. After concrete has cured at least 14 days, correct high areas by grinding.
 - 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 - 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

- F. Repair materials and installation not specified above may be used, subject to Owner's representative approval.

3.9 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Contractor will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Verification of use of required design mixture.
 - 4. Concrete placement, including conveying and depositing.
 - 5. Curing procedures and maintenance of curing temperature.
 - 6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 7. Compression Test Specimens: ASTM C 31.
 - a. Cast and laboratory cure two sets of three standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of three standard cylinder specimens for each composite sample.
 - 8. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 - 9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 - 10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive

strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

11. Test results shall be reported in writing to Owner's representative, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner's representative but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Owner's representative. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Owner's representative
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate that they do not comply with the Contract Documents. The corrections and any other work affected by or resulting from corrections to the concrete work shall be at the Contractor's expense.

SECTION 03500 – PRE-CAST / PRE-STRESSED CONCRETE**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Concrete materials.
- B. Patching and repairing.
- C. Grout.
- D. Moisture barrier.
- E. Inserts.

1.02 RELATED SECTIONS

- A. Section 31000 - Earthwork.
- B. Section 03100 - Concrete Form work.
- C. Section 03200 - Concrete Reinforcement.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Load test analysis
 - 2. Compressive strength test reports as specified in Article 3.10.
 - 3. Manufacturer's Literature: Materials description for proprietary products specified.
 - 4. Submit shop drawings to Owner's Representative. Include a layout plan, fabrication details, estimated camber, connection and anchorage details, and indicate member identification marks which appear on the manufactured units to facilitate field placement, and design calculations. Shop drawings and design calculations shall bear the seal & signature of an engineer registered in the state in which the building is erected.

1.04 QUALITY ASSURANCE

- A. The concrete work shall conform with the following except when in conflict with the building code in force; in such event the building code shall govern.
 - 1. Specifications for Structural Concrete for Buildings, ACI 301.
 - 2. Guide for Measuring, Mixing, Transporting, and Placing Concrete, ACI 304R.
 - 3. Building Code Requirements for Reinforced Concrete, ACI 318.
 - 4. Standard Specification for Cold Weather Concreting: ACI 306.1 when freezing conditions or mean daily temperature below 40 degrees F. is encountered.
 - 5. Hot Weather Concreting : ACI 305R when maximum daily temperature exceeds 85 degrees F. or rapid drying conditions exist. (Evaporation rate exceeds 0.15 lb./s.f./hr., per Figure 2.1.5).
- B. Conform to profiles indicated on drawings.
- C. Provide two hour fire rated construction on all precast prestressed concrete members.
- D. Design to support dead load and live load for indicated span conditions in ACI 318.
- F. Provide all anchoring devices, clips, plates, miscellaneous angles, and reinforcing as required for fabrication and erection.

1.05 DELIVERY, STORAGE AND HANDLING

- A. CONTRACTOR shall arrange for delivery to coincide with installation.
- B. Order materials promptly to avoid lead time problems and delays.

PART 2 EXECUTION

2.01 PREPARATION

- A. The concrete shall be coordinated with the work of the other trades to allow reasonable time to set sleeves, inserts and other accessories, which must be in position before concrete is placed.
- B. Provide all anchoring devices, clips, plates, miscellaneous angles, and reinforcing as required for fabrication and erection.
- C. Openings larger than 10" dia., 10" sq., or as indicated drawings shall be cast by the manufacturer in accordance with shop drawings. Field cut all other holes by manner of power saws or core drills. Repair all spalls or chips which will be exposed to view.
- D. In areas where members will be used exposed or painted as the finished ceiling, rake joints 1/2" deep.

2.02 PLACING PRE-CAST

- A. Erection includes placing, aligning and leveling members in final position welding of prestressed members to each other or to supporting members. Remove lifting hooks which will be exposed to view etc.

2.03 PATCHING PRE-CAST

- A. All concrete surfaces:
 - 1. Apply epoxy type bonding agent and patch all form tie holes, aggregate pockets, honeycomb and defective areas as required with 1:2 portland cement-sand mortar.
- B. Exposed to view concrete surfaces:
 - 1. Remove all fins, form joint marks, rough spots and other defects by grinding or rubbing with a carborundum stone, until these defects and rough areas are completely removed and surfaces are free from imperfections so as to present a dense, smooth, uniform finish.
 - 2. Thoroughly wet concrete surfaces and apply grout finish to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

2.04 EMBEDDED ITEMS

- A. General: Set and build into work, anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached.

2.05 GROUTING

- A. Grout structural base and bearing plates as soon as practical and before significant load is placed on bearing members. Mix, place and cure grout in accordance with the manufacturer's directions.
- B. Grout shall be a mixture of not less than one part portland cement to four parts fine sand, with consistency that joints can be completely filled without seepage over adjacent surface.

2.06 FIELD QUALITY CONTROL

- A. Testing laboratory shall perform the following tests:
 - 1. CONTRACTOR shall arrange to have pre-cast manufacturer substantiate to OWNER that precast members meet or exceed the required load capacities indicated in the drawings

- B. If in the opinion of the Owner's Construction Manager, foregoing tests indicate concrete strengths below those required, or visual defects indicate concrete of poor quality has been placed, additional tests shall be made and reported as directed by the Owner's Construction Manager at no additional cost to the Owner.

SECTION 4200 – UNIT MASONRY**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Concrete masonry units (CMUs).
 - 2. Decorative concrete masonry units.
 - 3. Face brick.
 - 4. Mortar and grout.
 - 5. Reinforcing steel.
 - 6. Masonry joint reinforcement.
 - 7. Ties and anchors.
 - 8. Embedded flashing.
 - 9. Miscellaneous masonry accessories.
 - 10. Masonry-cell insulation.
- B. Related Sections include the following:
 - 1. Section 04211 "Thin Brick Veneer System"
 - 2. Section 07150 "Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
 - 3. Section 07190 "Water Repellents" for water repellents applied to unit masonry assemblies.
 - 4. Section 07620 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
 - 5. Section 07900 "Joint Sealants" for sealing control and expansion joints in unit masonry.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels, furnished under Division 05 Section "Metal Fabrications," where indicated on Drawings.
 - 2. Manufactured reglets in masonry joints for metal flashing, furnished under Division

1.03 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples: For each type and color of the following:
 - 1. Decorative concrete masonry units.
 - 2. Face brick, in the form of straps of five or more bricks.
 - 3. Special brick shapes.
 - 4. Weep holes/vents.

5. Accessories embedded in masonry.
- D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- E. Qualification Data: For testing agency.
- F. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Grout mixes. Include description of type and proportions of ingredients.
 4. Reinforcing bars.
 5. Joint reinforcement.
 6. Anchors, ties, and metal accessories.
- G. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- H. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- D. Preconstruction Testing Service: Owner may engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by Owner. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
 1. Clay Masonry Unit Test: For each type of unit required, per ASTM C 67.
 2. Concrete Masonry Unit Test: For each type of unit required, per ASTM C 140.
 3. Mortar Test (Property Specification): For each mix required, per ASTM C 780.
 4. Grout Test (Compressive Strength): For each mix required, per ASTM C 1019.
- E. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

- F. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects.
 - 1. Build sample panels for typical exterior wall / typical interior wall in sizes approximately 48 inches long by 48 inches high.
 - 2. Clean one-half of exposed faces of panels with masonry cleaner indicated.
 - 3. Protect approved sample panels from the elements with weather-resistant membrane.
 - 4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Owner in writing.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.07 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. (Latest Editions).
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. (Latest Editions.)

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Refer to drawings.
 - 2. Manufacturers: Refer to drawings.

2.02 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.03 CONCRETE MASONRY UNITS (CMUs)

- A. Shapes: Provide shapes indicated and as follows:
 - 1. Provide special shapes for corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners, unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
 - 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
 - a. Products:
 - 1) Grace Construction Products, unit of W. R. Grace & Co. - Conn.; Dry-Block.
 - 2) Owner approved equal.
- C. Concrete Masonry Units: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
 - 2. Weight Classification: Medium weight, unless otherwise indicated.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
 - 4. Exposed Faces: Provide color and texture matching the range represented by Owner's furnished sample.
- D. Decorative Concrete Masonry Units: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
 - 2. Weight Classification: Medium weight.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
 - 4. Pattern and Texture:
 - a. Standard pattern, ground finish. Match Owner's samples.
 - b. Standard pattern, split-face finish. Match Owner's samples.
 - 5. Basis of Design Products:
 - a. Standard pattern, ground finish; Northfield Block Company; A-7.
 - b. Standard pattern, split-face finish; Northfield Block Company; 4916.

2.04 BRICK

- A. General: Provide shapes indicated and as follows:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 - 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 - 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: ASTM C 216, Grade SW, Type FBX.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
 - 2. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
 - 3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 - 4. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
 - 5. Products:
 - a. Refer to architectural drawings for brick selection

2.05 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- D. Masonry Cement: ASTM C 91.
- E. Mortar Cement: ASTM C 1329.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
- G. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
- H. Aggregate for Grout: ASTM C 404.
- I. Cold-Weather Admixture: Non-chloride, non-corrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - 1. Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company; Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
- J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
 - 1. Products:
 - a. Grace Construction Products, unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - b. Owner approved equal.
- K. Water: Potable.

2.06 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615 or ASTM A 996, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951.
 - 1. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 2. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
 - 3. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
 - 4. Wire Size for Veneer Ties: W2.8 or 0.188-inch diameter.
 - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 6. Provide in lengths of not less than 10 feet.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.188-inch- diameter, hot-dip galvanized, carbon-steel continuous wire.

2.07 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
 - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating.
 - 2. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
 - 1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
 - 2. Wire: Fabricate from 3/16-inch-diameter, hot-dip galvanized steel wire.
- D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 - 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, hot-dip galvanized steel wire.
 - 2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch diameter, hot-dip galvanized steel wire.
- E. Partition Top anchors: 0.097-inch thick metal plate with 3/8-inch diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- F. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins, unless otherwise indicated.
 - 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153.
- G. Adjustable Masonry-Veneer Anchors
 - 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
 - 2. Seismic Masonry-Veneer Anchors: Units consisting of a metal anchor section and a connector section designed to engage a continuous wire embedded in the veneer mortar joint.
 - 3. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene washer, No. 10 diameter by length required to penetrate steel stud flange with not less than 3 exposed threads,

and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

2.08 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
- B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153, Class C; of dimensions indicated.

2.09 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual and Division 07 Section "Flashing and Sheet Metal" and as follows:
 - 1. Stainless Steel: ASTM A 240, Type 304, 0.016 inch thick.
 - 2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
 - 3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - 4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 - 5. Fabricate through-wall flashing with drip edge, unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
 - 6. Fabricate through-wall flashing with sealant stop, unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
 - 7. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 3/8 inch to form a stop for retaining sealant backer rod.
- B. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:
 - 1. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.
 - a. Products:
 - 1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
 - 2) Firestone Building Products; FlashGuard.
 - 3) Heckmann Building Products Inc.; No. 81 EPDM Thru-Wall Flashing.
- C. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
 - 1. Product: Subject to compliance with requirements, provide "Blok-Flash" by Advanced Building Products Inc.
- D. Solder and Sealants for Sheet Metal Flashings: As specified in Division 07 Section "Flashing and Sheet Metal."
 - 1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
 - 2. Elastomeric Sealant: ASTM C 920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

- E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
 - 1. Dur-O-Wall; Rapid Soft-Joint/Expansion Joint.
 - 2. Hohmann & Barnard, Inc.; NS Series - Closed Cell Neoprene Sponge.
 - 3. Williams Products; SAS-1040 and EJS-1040.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
 - 1. Dur-O-Wall; Rapid Control Joint Rubber Compound.
 - 2. Heckmann Building Products; Rubber Control Joint.
 - 3. Hohmann & Barnard, Inc.; RS Series Rubber Control Joint.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Vinyl weep hole/vent, one-piece, offset, T-shaped units made from flexible, injection-molded PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color approved by Architect to match that of mortar.
 - 1. Hohmann & Barnard, Inc.; #343 Louvered Weep Hole.
 - 2. Williams Products, Inc.; Williams-Goodco Brick Vent.
 - 3. Wire-Bond; Louvered Weepholes.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
 - 1. Mortar Net USA, Ltd.; Mortar Net.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
 - 1. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - 2. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - 3. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - 4. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.11 MASONRY-CELL INSULATION

- A. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

2.12 MASONRY CLEANERS

- A. Masonry Cleaner: For all materials and methods for cleaning masonry, follow manufacturers recommendations. Do not use muriatic acid.
- B. Job-Mixed Detergent Solution: Solution of trisodium phosphate (1/2-cup dry measure) and laundry detergent (1/2-cup dry measure) dissolved in one gallon of water.
- C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new

masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.
2. For dark-colored masonry not subject to metallic oxidation stains, use formulation consisting of a liquid blend of surface-acting acids and special inhibitors.
3. For masonry subject to metallic oxidation stains, use formulation consisting of a liquid blend of organic and inorganic acids and special inhibitors.
 - a. Products: Subject to compliance with requirements, products that may be used to clean unit masonry surfaces include, but are not limited to, the following:
 - 1) ProSoCo, Inc.
 - 2) Diedrich Technologies, Inc.
 - 3) EaCo Chem, Inc.

2.13 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Limit cementitious materials in mortar to portland cement and lime.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 1. For masonry below grade or in contact with earth, use Type S.
 2. For reinforced masonry, use Type S.
 3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
- C. Grout for Unit Masonry: Comply with ASTM C 476.
 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.
- D. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Thickness: Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
 - 5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
 - 6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
 - 7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.03 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond, unless otherwise indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

- F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, and similar items, unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
 - 3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division Section 07930 "Fire-Resistive Joint Systems."

3.04 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and concrete masonry units as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.05 MASONRY-CELL INSULATION

- A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed.

3.06 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
 - 1. Space reinforcement not more than 16 inches o.c.
 - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
 - a. Reinforcement above is in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, pipe enclosures, and other special conditions.

3.07 ANCHORING MASONRY TO STRUCTURAL MEMBERS

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 - 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.08 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:
 - 1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 - 2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
 - 3. Embed connector sections and continuous wire in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of sheathing.
 - 4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 - 5. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
 - 6. Space anchors as indicated, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.09 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement. Placement is to be in accordance with the International Masonry Institute recommendations.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Form expansion joints in brick made from clay or shale as follows:
 - 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
 - 2. Build flanges of factory-fabricated, expansion-joint units into masonry.

3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division Section 07900 "Joint Sealants."
- D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.

3.10 LINTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated on Drawings.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 2. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
 3. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
 5. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Division 07 Section "Joint Sealants" for application indicated.
 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches o.c. at brick veneer, unless otherwise indicated.
 3. Space weep holes 32 inches o.c. at single-wythe cmu, unless otherwise indicated.
- F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.13 FIELD QUALITY CONTROL

- A. Inspectors: Owner may engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
 - 1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.
- B. Testing Agency: Owner may engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
 - 1. Payment for these services will be made by Owner.
 - 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- D. Clay Masonry Unit Test: For each type of unit provided, per ASTM C 67.
- E. Concrete Masonry Unit Test: For each type of unit provided, per ASTM C 140.
- F. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

3.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Section "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

SECTION 04211 - THIN BRICK VENEER SYSTEM**PART 1 GENERAL****1.1 GENERAL REQUIREMENTS**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the thin brick veneer system as shown on the drawings and/or specified herein, including, but not limited to, the following:
 - 1. Manufactured brick at exterior walls.
 - 2. Mortar, lath, fasteners and accessories.

1.3 RELATED SECTIONS

- A. Sheet Metal Flashing - Section 07620.
- B. Joint Sealers - Section 07900.

1.4 QUALITY ASSURANCE

- A. Installer: Experienced in similar types of work of similar scope and be able to furnish list of previous jobs and references if requested by Architect, and approved by the brick panel manufacturer.
- B. Control and Expansion Joints: Provide control and expansion joints installed at frequency and in accordance with details as recommended by the manufacturer. Confirm locations and frequency with the Architect before beginning work.
- C. Vertical and Lateral Fire Propagation Test Characteristics: The exterior wall assembly is required to comply with NFPA 285 "Standard Method of Test for the Evaluation of Flammability Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components." The base wall, stud cavity insulation, wall sheathing, air barrier and exterior cladding are components that are required to be evaluated as part of this specific assembly test. The basis-of-design product listed herein is a component of the design test assembly selected by the Architect.

1.5 SUBMITTALS

- A. Product Data: Submit for all specified products. Include all applicable physical and performance data.
- B. Samples: Submit 4 samples of thin brick veneer units to illustrate color, texture, and size range of each type unit.
 - 1. Four (4) sets of samples at least 8" x 12" of 3 courses, 1-1/2 bricks long.
 - 2. Indicate range of color and texture.
- C. Shop Drawings: Elevations and detail sections of thin brick veneer panels. Indicate anchorage and joint details, and relation to adjacent work.
- D. Material Certificates: Prior to delivery site, submit certificates indicating compliance with the applicable specifications for Thin Brick Grades, Types or Classes included in these specifications.
- E. Thin Brick Test Reports: Submit test reports substantiating compliance with requirements. Sample and test in accordance with ASTM C 67.
 - 1. Testing and reports shall be completed by an independent laboratory.
 - a. Test reports for each type of brick shall be submitted to the Architect/Engineer for review.
 - b. Thin brick test reports shall indicate:

- 1). 2-hour cold water absorption.
 - 2). 5-hour boil absorption.
 - 3). Saturation coefficient.
 - 4). Initial rate of absorption.
 - 5). Efflorescence.
- F. Sample Panel: Sample or mock-up panels shall be used to review installation process as well as thin brick and mortar color and serves as the standard of workmanship for the Project.
1. Build mockup panel for walls to receive thin brick veneer system as shown on drawings.
 2. Build Mock-up panels for thin brick veneer system in sizes approximately 4' x 4'.
 - a. All thin brick shipped for the sample shall be included in the panel.
 - b. Use panel as standard of comparison for all masonry work built of same material.
 - c. Where masonry is to match existing, erect panel adjacent and parallel to existing surface.
 - d. Clean one-half of exposed faces of panel with masonry cleaner as indicated and approved by manufacturer.
 - e. Protect accepted panel from the elements with weather-resistant membrane.
 - f. Approval of panel is for color, texture, and blending of masonry units; relationship of mortar to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - g. Do not start work until Architect has accepted sample panel.
 - h. Do not destroy or move panel until work is completed and accepted by the Architect.
- G. Manufacturer's detailed installation instructions.

1.6 PRODUCT HANDLING

- A. General: Deliver, store, handle and protect all materials from damage, moisture, dirt and intrusion of foreign matter. Store all veneer units and mortar materials on raised platforms and under ventilated and waterproof cover. Store packaged materials in manufacturer's unopened containers, marked with manufacturer's name and product brand name. Immediately reseal containers after partial use. Remove and replace damaged materials.
- B. Brick Units: Pack, deliver and store to prevent breakage, cracking, chipping, spalling or other damage. Store, protect, and ventilate units at project site.
- C. Aggregate: Store with provisions for good drainage.
- D. Lath: Store and protect so that, when placed, joint reinforcement and anchors will be free of soil, dirt, ice, loose rust, scale, or other coatings which would destroy or reduce bond with mortar, and will not be disfigured or bent out of shape.

1.7 JOB CONDITIONS

- A. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.
- B. Protection of Work
1. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
 2. Stain Prevention
 - a. Prevent adhesive, and mortar from staining the face of masonry.
 - b. Remove immediately grout or mortar in contact with face of such masonry.
 - c. To avoid smearing of adhesive on the face of masonry. Allow adhesive on face of installed masonry to set before trying to remove.
 - d. Protect all sills, ledges and projections from droppings of adhesive or mortar.
 - e. Protect the wall from rain-splashed mud and mortar splatter.
 - f. Turn scaffold boards closest to the wall on edge when work is not in progress to prevent rain from splashing mortar and dirt onto masonry.
- C. Cold Weather Requirements
1. Do not use frozen materials or materials mixed or coated with ice or frost.
 2. Do not build on frozen substrates.
 3. Remove and replace unit masonry damaged by frost or by freezing conditions.

4. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE
 5. Comply with manufacturer adhesive application and temperature requirements as stated in the manufacturer installation manual.
- D. Hot Weather Requirements
1. Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE
 2. Protect mortar from uneven and excessive evaporation.
 - a. The face of the installed thin brick may be dampened with water prior mortar installation to reduce the absorption of moisture from the mortar joint and increase bond
 - b. Veneer may be fogged with water to allow the mortar enough time to set. Apply only enough moisture to consistently dampen the wall without allowing water to run down the face.
 3. Comply with manufacturer's application and temperature requirements.
 4. Protect and shade panels from extended exposure direct sun. Excessive heat gain can cause adhesive to flow.

1.8 WARRANTY

- A. Manufacturer shall provide a 15-year limited warranty against manufacturing defects of manufactured stone units.
- B. Contractor and manufacturer shall provide a three year warranty against movement of stone from surface, including loosening and slippage. Contractor shall repair any stones at no cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Brick: As indicated on Drawings.
 1. Sizes and Bond Pattern: As indicated.
 2. ASTM C 1088-88, Grade SW, Type TBX.
 - a. See architectural finish schedule for brick manufacturer, color, finish and size.
 3. Special shapes, corner bricks, trim pieces and loose brick slabs.

2.2 ACCESSORY MATERIALS

- A. Reinforcing: ASTM C 847, 2.5lb/yd² galvanized expanded metal lath; ASTM C 847, 3.4lb galvanized 3/8" rib lath; or ASTM C 1032, 17-gauge woven wire mesh complying with code agency requirements for the type of substrate over which stone veneer is installed.
- B. Air and Water Barrier Membrane: Laticrete MVIS system membrane.
- C. Epoxy Waterproofing Flashing Mortar: LATAPOXY® Waterproof Flashing Mortar ; 3 component epoxy, trowel applied specifically designed to be used under adhered masonry veneer:
 1. Breaking Strength (ANSI A118.10): 450-530 psi
 2. Waterproofness (ANSI A118.10): No Water penetration
 3. 7 day Shear Bond Strength (ANSI A118.10): 110-150 psi
 4. 28 day Shear Bond Strength (ANSI A118.10): 90-120 psi
 5. 12 Week Shear Bond Strength (ANSI A118.10): 110-130 psi
- D. Latex-Portland Cement Mortar for leveling beds and scratch/plaster coats: LATICRETE MVIS Premium Mortar Bed to meet the following physical requirements:
 1. Compressive Strength (ANSI A118.4 Modified): >4000 psi
 2. Water Absorption (ANSI A118.6): ≤ 5%
 3. Service Rating (TCA/ASTM C627): Extra Heavy
 4. Smoke & Flame Contribution (ASTM E84 Modified): 0
- E. Latex Portland Cement Pointing Mortar / Grout: MVIS Pointing Mortar; weather, frost and shock resistant, as well as meet the following physical requirements:
 1. Compressive Strength (ASTM C91): 3500 psi

2. Smoke & Flame Contribution (ASTM E84 Modified): 0
- F. Expansion and Control Joint Sealant: MVIS Silicone Sealant; a one component, neutral cure, exterior grade silicone sealant and meet the following requirements:
 1. Tensile Strength (ASTM C794): 280 psi
 2. Hardness (ASTM D751; Shore A): 25 (colored sealant) / 15 (clear sealant)
 3. Weather Resistance (QUV Weather-ometer): 10000 hours (no change)
- G. Spot Bonding Epoxy Adhesive: LATAPOXY 310 Stone Adhesive (Standard or Rapid Grade) for installing adhered masonry veneer, brick and stone over vertical and overhead surfaces shall be high strength, high temperature resistant, non-sag and shall meet the following physical requirements:
 1. Thermal Shock Resistance (ANSI A118.3): >1000 psi
 2. Water Absorption (ANSI A118.3): 0.1 %
 3. Compressive Strength (ANSI A118.3): >8300 psi
 4. Shear Bond Strength (ANSI A118.3 Modified): >730 psi
- H. Metal Lath: 18 gauge galvanized woven wire mesh, 3.4 lb. self-furring diamond mesh.
- I. Fasteners: 1-1/4" Type S-12 Pancake Head Super Tite Screws with Climaseal finish, by USG.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Inspect related conditions; do not start work in an area until adverse conditions in that area are corrected.

3.2 PREPARATION

- A. Test surfaces for straightness, levelness. Notify Architect where corrections are needed.
 1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 2. Verify that thin-brick veneer may be completed in accordance with all pertinent codes and regulations, the referenced standards, and the original design.
 3. Do not start any work until mock-ups are approved by the Architect.
- B. Discrepancies
 1. In the event of discrepancy, immediately notify the Architect.
 2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.3 INSTALLATION

- A. Conform to the Brick Association "Thin Brick Veneer Technical Notes."
- B. Install thin brick in accordance with manufacturer's printed instructions.
- C. Cut units where required for fitting or for installation of built-in items, using power tools; do not install units having chipped or cracked edges on sight-exposed surfaces.
- D. Align base courses to follow accurate floor lines.
- E. Align faces plumb, level, and true, with uniform joint widths.
- F. Size and portion units for best appearance, with joints arranged neat and symmetrical, free of imperfections detracting from overall appearance.

3.4 FIELD QUALITY CONTROL

- A. Architect will observe appearance of installed units; installed masonry surfaces shall be free of imperfections which detract from overall appearance when viewed from a distance of 5 feet at 90 degrees normal to surface

3.5 CLEANING

- A. Clean installed masonry surfaces in accordance with manufacturer's instructions; do not clean units with products not specified in manufacturer's instructions.

SECTION 04720 – CAST STONE MASONRY**PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Related Sections include the following:
 - 1. Division Section 04200 "Unit Masonry" for installing cast stone units in unit masonry.

1.03 DEFINITIONS

- A. Cast Stone: Architectural pre-cast concrete building units intended to simulate natural cut stone.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cast stone units.
- B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
 - 1. Include building elevations showing layout of units and locations of joints and anchors.
- C. Samples for Verification:
 - 1. For each color and texture of cast stone required, 10 inches square in size.
 - 2. For colored mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicated types and amounts of pigments used.
- D. Full-Size Samples: For each type of cast stone unit required.
 - 1. Make available for Owner's review at Project site.
 - 2. Make Samples from materials to be used for units used on Project.
 - 3. Approved Samples may be installed in the Work.
- E. Qualification Data: For manufacturer and testing agency.
 - 1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C 1364.
- F. Quality-Control Plan: Manufacturer's written quality-control plan that includes all elements of the Cast Stone Institute's "Quality Control Procedures Required for Plant Inspection."
- G. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, with sufficient production capacity to manufacture required units.
 - 1. Manufacturer is a producing member of the Cast Stone Institute or has on file and follows a written quality-control plan approved by Architect that includes all elements of the Cast Stone Institute's "Quality Control Procedures Required for Plant Inspection."
- B. Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

- C. Source Limitations for Cast Stone: Obtain cast stone units through one source from a single manufacturer.
- D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.
- E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build mockup of typical wall area as shown on Drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to minimize the need for on-site storage and to avoid delaying the Work.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with non-staining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store installation materials on elevated platforms, under cover, and in a dry location.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.07 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain until cast stone has dried, but not less than 7 days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.01 CAST STONE MATERIALS

- A. General: Comply with ASTM C 1364 and the following:
- B. Portland Cement: ASTM C 150, Type I, containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation as needed to produce required textures and colors as needed to produce required cast stone colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation as needed to produce required textures and colors as needed to produce required cast stone colors.
- E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, non-fading, and resistant to lime and other alkalis.
- F. Admixtures: Do not use admixtures unless specified or approved in writing by Owner.
 - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
 - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.

3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
4. Water-Reducing Admixture: ASTM C 494, Type A.
5. Water-Reducing, Retarding Admixture: ASTM C 494, Type D.
6. Water-Reducing, Accelerating Admixture: ASTM C 494, Type E.
- G. Reinforcement: Deformed steel bars complying with ASTM A 615. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast stone material.
 1. Epoxy Coating: ASTM A 775.
- H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A 240, ASTM A 276, or ASTM A 666, Type 304.

2.02 CAST STONE UNITS

- A. Provide cast stone units complying with ASTM C 1364 using the vibrant dry tamp or wet-cast method.
 1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666, Procedure A, as modified by ASTM C 1364, or are made from cast stone that has a history of successful resistance to freezing and thawing.
- B. Fabricate units with sharp arris and details accurately reproduced with indicated texture on all exposed surfaces, unless otherwise indicated.
 1. Slope exposed horizontal surfaces 1:12, unless otherwise indicated.
 2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
 3. Provide drips on projecting elements, unless otherwise indicated.
- C. Fabrication Tolerances:
 1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
 2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
 3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
 4. Location of Grooves, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
- D. Cure units by one of the following methods:
 1. Cure units with steam in enclosed curing room at temperature of 105 deg F or above and 95 to 100 percent relative humidity for 6 hours.
 2. Cure units with dense fog and water spray in enclosed warm curing room at 95 to 100 percent relative humidity for 24 hours.
 3. Cure units to comply with one of the following:
 - a. Not less than 5 days at mean daily temperature of 70 deg F or above.
 - b. Not less than 6 days at mean daily temperature of 60 deg F or above.
 - c. Not less than 7 days at mean daily temperature of 50 deg F or above.
 - d. Not less than 8 days at mean daily temperature of 45 deg F or above.
- E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
- F. Colors and Textures: As selected by Owner from manufacturer's full range.

2.03 MORTAR MATERIALS

- A. Provide mortar materials that comply with Division Section 04200 "Unit Masonry."

2.04 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from stainless steel complying with ASTM A 240, ASTM A 276, or ASTM A 666, Type 304.
- B. Dowels: Round stainless-steel bars complying with ASTM A 276, Type 304, and 1/2-inch diameter.
- C. Proprietary Acidic Cleaner: Manufacturer's standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cast stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.
 - 1. Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. ProSoCo, Inc.

2.05 MORTAR MIXES

- A. Comply with requirements in Division Section 04200 "Unit Masonry" for mortar mixes.

2.06 SOURCE QUALITY CONTROL

- A. Employ an independent testing agency to sample and test cast stone units according to ASTM C 1364.
 - 1. Include one test for resistance to freezing and thawing.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of cast stone.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SETTING CAST STONE IN MORTAR

- A. Install cast stone units to comply with requirements in Division Section 04200 "Unit Masonry."
- B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
 - 1. Install anchors, fasteners, and other attachments indicated or necessary to secure units in place.
- C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
- D. Set units in full bed of mortar with full head joints, unless otherwise indicated.
 - 1. If not indicated, set units with joints 1/4 to 3/8 inch wide.
 - 2. Build anchors and ties into mortar joints as units are set.
 - 3. Fill dowel holes and anchor slots with mortar.
 - 4. Fill collar joints solid as units are set.
 - 5. Build concealed flashing into mortar joints as units are set.
 - 6. Keep head joints in coping and other units with exposed horizontal surfaces open to receive sealant.
- E. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
- F. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

- G. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- H. Provide control and pressure-relieving joints of widths and at locations indicated. Keep joints free of mortar and other rigid materials. Form open joint of width indicated, but not less than 3/8 inch.
- I. Prepare joints indicated to receive sealant and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."
 - 1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant, unless otherwise indicated.

3.03 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

- A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
 - 1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
 - 2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.
- B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.
- C. Fill anchor holes with sealant. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.
- D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.
- E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.
 - 1. Form open joint of width indicated, but not less than 3/8 inch.
- F. Prepare joints and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."
 - 1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant, unless otherwise indicated.

3.04 INSTALLATION TOLERANCES

- A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.
- D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except due to warpage of units within tolerances specified.

3.05 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Owner.
- B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean cast stone as work progresses.
 - 1. Remove mortar fins and smears before tooling joints.

2. Remove excess sealant immediately, including spills, smears, and spatter.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Owner's approval of sample cleaning before proceeding with cleaning of cast stone.
 3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
 5. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions. Do not use Muriatic Acid.

SECTION 05120 – STRUCTURAL STEEL**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Structural steel members essential to support the design loads.
- B. Grout

1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 General Requirements apply to this section.
- B. Section 03300 - Cast-In-Place Concrete: For grouting of base plates, and installation of anchor bolts and embeds for anchoring structural steel to concrete.
- C. Section 04200 - Unit Masonry: For installation of anchor bolts and embeds for anchoring structural steel to masonry.
- D. Section 05210 - Steel Joists.
- E. Section 05310 - Steel Deck.
- F. Section 09900 - Painting.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Shop Drawings: Complete fabrication and erection details and schedules.
 - a. Shop Drawings shall have been thoroughly checked by fabricator before being submitted for review. Review is precautionary measure only and shall not relieve fabricator of full responsibility of correctness of materials, sizes, dimensions and details.
 - b. If structural sections and other details indicated on Drawings cannot be readily obtained, substitution of sections and other details of equal strength which conform to requirements of design may be made only if approved.
 - c. Fabrication shall not proceed until shop drawings have been reviewed. Fabrication, assembly and erection shall conform to reviewed shop drawings.

1.04 QUALITY ASSURANCE

- A. Testing Agency: Owner may engage a qualified independent testing and inspection agency to inspect field welds and high strength bolted connections.
- B. Bolted Connections: Shop bolted connections may be tested and inspected according to RCSC's "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field Welds will be visually inspected according to AWS D1.1
 - 1. In addition to visual inspections, field welds may be tested by Owner according to AWS D1.1 and the following inspection procedures:
 - a. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finish weld. Cracks or zones of incomplete fusion will not be accepted.
 - b. Ultrasonic Inspection: ASTM E 164.
- D. Comply with AISC Manual:
 - 1. "Steel Construction Manual, AISC 360".
- E. Comply with AISC Manual:
 - 1. "A Guide to the Shop Painting of Structural Steel".
 - 2. "Specifications for Architecturally Exposed Structural Steel".
- F. "Code of Standard Practice for Steel Buildings and Bridges":
 - 1. Paragraph 4.2.1 of the above code is hereby modified by deletion of the following sentence: "This approval constitutes the Owner's acceptance of all responsibility for the

design adequacy of any connections designed by the fabricator as a part of his preparation of these shop drawings".

- G. Welding shall comply with American Welding Society "Structural Welding Code - Steel" AWS D1.1.
- H. "Specifications for Assembly of Structural Joints Using High Strength Steel Bolts" as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Fabricate for delivery sequence which will expedite erection and minimize field handling. Identify pieces with suitable mark conforming to erection drawings.
- B. Deliver structural steel to the Project site and store to avoid damage and distortion of material. Material damaged due to mishandling shall be replaced at no additional cost to the Owner.

1.06 SITE CONDITIONS

- A. Do not perform welding below 0 degrees F. Preheat material to be welded and maintain interpass temperatures as required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Wide Flange Shapes: ASTM A992.
- B. Angles, Plates, Channels, etc.: ASTM A36
- C. Structural Tubes: ASTM A500, Grade B, 46 ksi.
- D. Welded Connections: AWS D1.1.
- C. Welding Electrodes: AWS Specifications, Serial Designation A233 (E-70).
- D. High Strength Bolts: ASTM A325 or A490.
- E. Anchor Rods: ASTM F1554, Grade 36.
- F. Shop Coat Paint: Fabricators standard rust-inhibiting primer containing no lead-bearing components and meeting current Federal and State regulations concerning lead in paint, and similar to #4080 Red Oxide Zinc Chromate Primer (Hentzen Coatings, Inc.); for interior, normally dry environment.
 - 1. For more severe exposure than those specified above and for architecturally exposed steel such as at pit openings, refer to Division 9 – Painting.
- G. Bituminous Coating: ASTM D1187 asphalt emulsion.

2.02 FABRICATION

- A. Take field measurements as required to verify and supplement dimensions shown on Drawings.
- B. Material shall be properly marked and match-marked where field assembly is required. The sequence of shipments shall be necessary as to expedite and minimize the field handling of material.
- C. Members shall be cambered upward where shown on the Drawings and be so marked for clear identification.
- D. Built-up sections assembled by welding shall be free of warpage, and all axes shall have true alignment.
- E. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AISC.
- F. Shop and field welding shall conform to AWS and AISC Standards and Specification.
- G. Flame cutting of steel will not be permitted.

- H. Provide anchor bolts and embedded plates for anchoring structural steel to supporting concrete and masonry. Furnish detailed plans showing exact locations of all bolts to be built into concrete and masonry as soon as possible. Furnish templates as required.
- I. Connections:
 - 1. Field connections shall be bolted, with ASTM 325 or A490 bolts unless otherwise shown on Drawings. Tightening shall be done in accordance with Section 5 of AISC Specification for Structural Joints. All bolts shall be torqued to a minimum of 330 ft. pounds and tested with a torque wrench. Field welded connections shall be used only where specifically shown on Drawings or with Structural Engineer's approval.
 - 2. Shop connections may be welded or bolted with high strength bolts at fabricator's option. Shear connections shall be welded or bolted with high strength bolts.
 - 3. High strength bolts shall be installed in strict compliance with AISC Specifications and ASTM requirements for installation of bolts.
 - 4. Field and shop welds shall be by certified welders only. Certificates should be available for inspection by Owner's Construction Manager.
 - 5. Connections not specifically shown shall fully develop critical load for member being connected.
 - 6. Bolts where used shall have cut washers under nuts and no threads allowed to bear on parts being connected.
 - 7. Bearing ends of columns and trusses shall be milled or sawed for true bearing on base and bearing plates. Rough bearing ends shall not be used.

2.03 CLEANING AND SHOP PAINTING

- A. Steel shall be cleaned of rust, mill scale, dirt and foreign matter before application of shop coat of paint.
- B. Paint structural steel with 1 (one) smooth coat of Alkyd primer with SSPC 6 (A) surface preparation.. Apply 2 coats on surfaces not accessible after erection.
- C. Shop coat shall result in a 2 mil (minimum) dry film thickness.
- D. Steel items to be embedded in concrete and steel items to be fireproofed shall not receive shop coat. Steel to receive field welded connections of primary structural importance shall not receive shop coat of paint but shall be painted in field instead.
- E. Hand clean and solvent clean unpainted and damaged shop coat areas and touch-up with a compatible shop coat primer.

PART 3 EXECUTION

3.01 ERECTION

- A. Material stored at the Project site shall not exceed design loads on structures so the members will not be distorted or otherwise damaged; and shall be protected against corrosion or deterioration.
- B. Confer with other trades and procure necessary templates and other information required to establish number, size and location of holes or other details necessary for attachment of items to structural steel.
- C. Burning shall not be used to form holes, enlarge holes or to otherwise modify connections. No member shall be altered in field unless approved in writing by Engineer.
- D. Temporary bracing throughout erection and construction shall be introduced wherever necessary to take care of loads to which structure may be subjected including equipment and operation of same. Wherever piles of material, erection equipment and other loads are carried during erection, proper provisions shall be made to safely support these abnormal loads.
- E. Members shall be cut neat, square and should be erected true and flush without twists and open joints. Light drifting to draw holes together may be used. Reference should be made to codes and specifications listed in this Section under Quality Assurance which govern fabrication, details, erection and workmanship. Responsibility for errors in

- fabrication and for proper fitting of various members shall be assumed by the structural steel fabricator.
- F. Column bases shall be set on steel shims not to exceed ½" high. Grouting of column bases is specified in Section 03300.
 - G. Steel exposed to view shall be free of surface imperfections and ground off to true surfaces. Exposed welds shall be ground smooth.

3.02 ADJUSTING AND CLEANING

- A. After erection, bolts, field welds, and scratched and abraded areas shall be properly cleaned and touched-up with the same paint used for the shop coat. Apply brush or spray paint to provide a minimum dry film thickness of 2 mils.

SECTION 05210 – STEEL JOISTS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Steel joists.
- B. Bridging
- C. Joist accessories.

1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 General Requirements apply to this section.
- B. Section 05120 - Structural Steel.
- C. Section 05310 - Steel Deck.
- D. Section 05500 - Metal Fabrications.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Specifications and design data.
 - 2. Welding certificates.
 - 3. Manufacturer's certificates and qualification data.
 - 4. Mill Certificates.
 - 5. Field quality control test and inspection reports.
 - 6. Shop Drawings: Show joist layout, details of bearing, anchorage, bracing, etc.
 - 7. Design Calculations: Submit calculations stamped by a licensed structural engineer who certifies that the joists have been designed in accordance with SJI standard specifications.
 - a. This submittal is waived if fabricator is an SJI member, except submittals for special joists shown on the Drawings, and joists which require revisions due to increased mechanical loads and other loads not shown on the Drawings.

1.04 QUALITY ASSURANCE

- A. Testing Agency: Owner may engage a qualified independent testing and inspection agency to inspect field welds and high strength bolted connections.
- B. Bolted Connections: Shop bolted connections may be tested and inspected according to RCSC's "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field Welds will be visually inspected according to AWS D1.1
 - 1. In addition to visual inspections, field welds may be tested by Owner according to AWS D1.1 and the following inspection procedures:
 - a. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finish weld. Cracks or zones of incomplete fusion will not be accepted.
 - b. Ultrasonic Inspection: ASTM E 164.
- D. Steel joists shall be standard prefabricated units of a member manufacturer of the Steel Joist Institute that conforms to SJI Standard Specification Load Tables.
- E. The design, fabrication, and erection of steel joists shall be in accordance with the "Standard Specifications and Load Tables for Open Web Steel Joists/Longspan Steel Joists" of the Steel Joist Institute, latest edition, except as otherwise shown on the Drawings or specified herein.
- F. Welding shall comply with American Welding Society "Structural Welding Code - Steel" AWS D1.1 and AWS D1.3, "Structural Welding Code – Sheet Steel."

- D. Deliver, handle and store joists as recommended by SJI specifications. Exercise care to avoid damage through rough handling during hauling, unloading, storing and erecting. Joists shall not be dropped, and overstressed. Store joists above grade. Damaged and otherwise unsuitable material when determined, shall be immediately removed from the Project site.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Structural Steel: ASTM A36/A242/A529/A572/A588 and SJI's "Specifications" for web and steel angle chord members.
- B. Welding Electrodes: AWS Specifications.
- C. Accessories: Provide applicable accessories necessary to complete the installation, such as but not limited to side and end wall anchors, headers, horizontal or diagonal bridging, extended ends, full bottom chord extensions, joist bearing plates, anchor bolts, and government anchors.
- D. Carbon steel bolts and threaded fasteners: ASTM 307, Grade A, carbon steel, hex-headed bolts and threaded fasteners; carbon steel nuts,; and flat unhardened steel washers.
 - 1. Finish: Plain, uncoated Hot-dip zinc coating, ASTM A 153, Class C.
- E. Shop Paint Rust inhibitive paint complying with Steel Joist Institute Specifications of latest adoption, and SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SPCC-Paint 15, and compatible with fireproofing specified (if any).

2.02 FABRICATION

- A. Fabricate K-Series steel joists in accordance with SJI's "Standard Specifications for Open Web Steel Joists – K Series" and load tables.
- B. Top chords shall be designed as continuous members subject to direct and bending stresses, in accordance with the standard specifications
- C. Camber joists in accordance with SJI's standard specifications or as indicated on drawings.
- D. Steel joists shall be of type shown.
- E. Minimum bearing for joists shall be 2-1/2" on steel and 4" on masonry.
- F. Size, type, and spacing of bridging shall be in accordance with Steel Joist Institute recommendations, unless otherwise shown.
- G. Joints of steel joists shall be made by arc-welding. Connections at ends of members shall be proportioned to develop actual design stress but not less than 50 percent of the allowable design strength of the members.
- H. Ceiling extensions for joist ends shall be furnished where suspended ceilings occur below joists.
- I. Thoroughly clean joists and accessories and apply a shop coat of paint specified to provide a minimum dry film thickness of 1.5 mils. Portions of joists to receive fireproofing shall not receive shop coat.
- J. Provide horizontal or diagonal type bridging for "open web" joist that are designed per the SJI Specifications.
- K. Provide bridging anchors for ends of all bridging lines terminating at walls or beams.

PART 3 EXECUTION

3.01 ERECTION

- A. Place and anchor the steel joist in accordance with SJI Specifications and final shop drawings.

- B. Field welded and bolted connections shall be in accordance with SJI standard specifications for type of joist used.
- C. Where joists are supported on steel members they shall be connected by welding unless otherwise shown.
- D. Furnish and place bearing plates and other devices required to be embedded into masonry and concrete elements.
- E. As soon as joists are erected they shall be permanently fastened in place and bridging completely installed before the application of loads. Bridging shall be continuous, and anchored to end walls and beams.
- F. After erection of joists touch-up welds and surfaces where shop paint has been abraded and where improperly applied, with same paint used for shop coat.

SECTION 05310 – STEEL DECK**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Steel roof deck.
- B. Decking accessories.

1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 General Requirements apply to this section.
- B. Section 05120 - Structural Steel
- C. Section 05500 - Metal Fabrications.

1.03 SUBMITTALS

- 1. Manufacturer's Literature: Description of decking and installation instructions.
- 2. Welding certificates
- 3. Field quality control test and inspection reports
- 4. Shop Drawings: Show decking layout, openings required for other parts of the Work, support of decking at openings and sheet metal accessories.

1.04 QUALITY ASSURANCE

- A. Testing Agency: Owner may engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Conform with the following:
 - 1. American Iron and Steel Institute "Specification for the Design of ColdFormed Steel Structural Members" (19B0), and specifications.
 - 2. American Welding Society "Structural Welding Code - Sheet Steel" D1.3
 - 3. Steel Deck Institute (SDI) "Design Manual for Composite Decks, Form Decks and Roof Decks".
- C. Welding operators employed to execute welding, shall be previously qualified by test as prescribed in the American Welding Society's "Standard Qualification Procedure" D1.3 or by such other tests as governmental agencies having jurisdiction may prescribe. Welds shall be made only by operators who are qualified to perform the type of work required, as evidenced by their passing the above prescribed tests. Tests completed earlier than 12 months prior to their employment on the work shall not be acceptable. Assume all costs in connection with operator certification.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle the metal decking to avoid damage. When so determined, damaged sheets and related decking materials shall be immediately removed from the Project site. Store sheets and related decking materials so that they are not in contact with the ground and so that they are properly supported, covered and kept dry.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Steel Sheets:
 - 1. Carbon steel sheets, ASTM A611, Grade C.
- B. Shop Finish:

1. Galvanized standard with the deck manufacturer.

2.02 MANUFACTURER'S

- A. Steel Deck Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Epic Metals Corporation
 2. Nucor Corporation; Vulcraft Division
 3. Roof Deck, Inc.
 4. United Steel Deck, Inc.
 5. Verco Manufacturing Company
 6. Wheeling Corrugating Company; Division of Wheeling-Pittsburgh Corp.

2.02 DECK TYPES

- A. Provide the following types where shown on the Drawings; units shall have 2" end laps and nesting side laps:
 1. Intermediate-Rib Deck: Depth approximately 1 1/2"; ribs spaced not more than 6" o.c.; width of rib opening at roof surface not more than 1 3/4"; width of bottom rib surface not less than 1/2". The deck is to be Type F and not less than 22 gauge. Fabricate metal closure strips of not less than 20 gauge sheet steel of the same quality as the deck units. End joints overlapped 2" minimum.
 2. Galvanized shop primed steel sheet: ASTM 653, Structural Steel, Grade 33, G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust inhibitive primer – color White.

2.03 ACCESSORIES

- A. Sheet metal accessories shall be of the same material and finish as the deck, unless otherwise shown or specified. Sheet metal accessories include but are not necessarily limited to:
 1. Hanger slots and strips.
 2. Transition plates.
 3. Closure plates at edge of deck, where required
 4. Weld Washers: Uncoated sheet steel, shaped to fit deck rib, 0.0598" thick, with factory punched hole of 3/8" diameter.
 5. Mechanical Fasteners: Corrosion resistant, low velocity, power actuated or pneumatically driven carbon steel fasteners; or self-drilling, self threading screws.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the supporting work and conditions under which metal decking is to be erected and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install the metal decking and accessories in accordance with the manufacturer's instructions, final Shop Drawings and erection layouts. Place decking units on the supporting steel, align and adjust to final position before permanently fastening. Unless otherwise shown, units shall span 3 or more support spacing. Do NOT stretch or contract the side lap interlocks. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.

- B. Where TKS screws cannot be used weld with weld washers as required.
- C. Side lap fastening by screws are required at panel laps in accordance with manufacturer's recommendations and to satisfy structural diaphragm. Permanently fasten roof deck units to steel supporting members with #12 TKS screws not less than 12" o. c. at supports and at closer spacing where required.
- D. Reinforcement at openings: Provide additional metal reinforcement and closure pieces as required for strength and continuity of decking. The steel reinforcement sheet shall be the same gauge as the deck but not less than 20 ga. and should be welded at 12" on center to the surrounding top surfaces of the deck. Openings 15" or less should be reinforced with a single plate with equivalent opening cut out of plate. The sheet size should be a minimum of 12" larger than the opening on both sides.
- E. Closure Strips: Provide metal closure strips at open uncovered ends and edges of roof decking, and in voids between decking and other construction. Weld into position to provide a complete decking installation.
- F. After roof decking installation, wire brush, clean and paint scarred areas, welds, and rust spots on the top and bottom surfaces of decking unites and supporting steel members. Touch-up shop painted surfaces with the galvanizing repair paint.
- G. In the areas where touch-up painted surfaces are to be exposed, apply the paint to blend into the adjacent surfaces in a manner that will minimize visual discontinuity in the coatings.

SECTION 05400 – LIGHT GAUGE METAL FRAMING**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Load-bearing steel framing.

1.02 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 1 General Requirements apply to this section.
- B. Section 05120 - Structural Steel.
- C. Section 09250 - Gypsum Wallboard: For 20 gauge and lighter nonload-bearing steel studs.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Product information and installation instructions for each item of lightgauge framing and accessories.
 - 2. Shop Drawings: Submit shop drawings for special components and installations not fully dimensioned and not detailed in manufacturer's product data.
 - a. Include placing drawings for framing members showing size and gauge designations, number, type, location and spacing. Indicate supplemental strapping, bracing, splices, bridging, accessories, and details required for proper installation.
- B. Welding certificates.
- C. Qualification Data: For Installer and fabricator.
- D. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Non-shrink grout.
- E. Source quality-control test reports.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code—Steel."
- D. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. AISC's "Steel Construction Manual, AISC 360."
 - 3. AISI "Specification for the Design of Cold-Formed Steel Structural Members".
- E. Design criteria:
 - 1. Wind loads in accordance with the governing state or local Building Code.
 - 2. Deflection: Less than L/600 for masonry exterior veneer.
- F. Fire-Rated Assemblies:
 - 1. Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units which have been approved by governing authorities having jurisdiction.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.

- 3. Non-shrink grout.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect metal framing units from rusting and damage. Deliver to project site in manufacturer's unopened containers or bundles; fully identified with name, brand, type and grade. Store off ground in a dry ventilated space or protected with suitable waterproof coverings if stored outdoors.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Alabama Metal Industries Corp.
- B. Consolidated Steel, Inc.
- C. Clark-Dietrich Industries, Inc.

2.02 SYSTEMS

- A. General: With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as recommended by manufacturer for applications indicated, and as needed to provide a complete metal framing system.
- B. Manufacturer's standard load-bearing steel studs and joists of size, shape and gauge as determined by manufacturer's registered engineer.

2.03 MATERIALS

- A. Stud and track sizes shall be as shown on drawings. Unless otherwise shown on Drawings, studs shall be 18 gauge minimum and tracks shall be 18 gauge minimum to fit studs complying with ASTM A446, A570, or A611.
- B. Finishes:
 - 1. Provide galvanized finish complying with ASTM A525 for minimum G-60 coating on metal framing and components, for exterior wall and roof applications.
 - 2. Provide prime coated finish with one coat of shop-applied red-oxide, zinc-chromate, or other similar rust-inhibitive primer, for interior framing.
- C. Use cadmium plated screws for anchoring brick veneer

2.04 LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-5/8 inches, unless otherwise indicated on Drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-5/8 inches, unless otherwise indicated on Drawings.
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1 5/8 inches.

2.05 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1-5/8 inches, unless otherwise indicated on Drawings.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-5/8 inches, unless otherwise indicated on Drawings.
- C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal and lateral loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0428 inch.
 - 2. Flange Width: 1 inch plus the design gap for 1-story structures.

2.06 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. Anchor clips.
 - 5. End clips.
 - 6. Foundation clips.
 - 7. Gusset plates.
 - 8. Stud kickers, knee braces, and girts.
 - 9. Hangers and end closures.
 - 10. Hole reinforcing plates.
 - 11. Backer plates.

2.07 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.
- B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153, Class C.
- C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

2.08 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Non-metallic, Non-shrink Grout: Premixed, nonmetallic, non-corrosive, non-staining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.
- D. Shims: Load bearing, high-density multi-monomer plastic, non-leaching.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.09 FABRICATION

- A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
 - 1. Fabricate framing assemblies using jigs or templates.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
 - 4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine the areas and conditions under which the work is to be performed and notify Contractor in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Before sprayed fire-resistive materials are applied (when required by construction), attach

- continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials, when required.
- B. After applying sprayed fire-resistive materials (when required by construction), remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage, when required.
 - C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
 - D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.03 INSTALLATION

- A. General: Install metal framing systems in accordance with manufacturer's printed instructions and recommendations and as specified herein.
- B. Installation of Vertical Stud System: Secure studs by either welding or screw fastening at both inside and outside flanges.
 - 1. Install continuous tracks sized to match studs. Align tracks accurately to layout at base and/or tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24" o.c. spacing for nail or powder-driven fasteners, or 16" o.c. for other types of attachment. Provide fasteners at corners and ends of tracks.
 - 2. Set studs plumb, except as needed for diagonal bracing and as required for non-plumb walls, warped surfaces and similar requirements.
 - 3. Where stud system abuts structural columns and walls including masonry walls, anchor ends of stiffeners or supporting structure.
 - 4. Install supplementary framing, blocking and bracing in metal framing system wherever walls and partitions are indicated to support work requiring attachment to the wall and partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case.
 - 5. Frame both sides of expansion and control joints with separate studs; do not bridge the joint with components of stud system.
 - 6. Install horizontal bridging in stud system, spaced (vertical distance) at not more than 4'-0" o c. unless design requires stricter spacing. Weld at each intersection.
- C. Field Painting: Touch-up shop-applied protective coating damaged during handling and installation. Use compatible primer for prime coated surfaces, use galvanizing repair paint for galvanized surfaces.

3.04 LOAD-BEARING WALL INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: 24 inches.
- B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 - 1. Stud Spacing: 16 inches.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.

- F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.
- G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
 - 2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
 - 1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.
 - I. Install horizontal bridging in stud system, spaced 48 inches. Fasten at each stud intersection installed according to manufacturer's written instructions.
- J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.05 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.
- B. Fasten both flanges of studs to top and bottom track, unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing shall be per drawings, with 16 inches on center maximum.
- C. Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single-leg deflection tracks and anchor to building structure.
 - 2. Connect vertical deflection clips to infill studs and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
 - 1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of flat, taut, steel sheet straps of width and thickness indicated and stud or stud-track solid blocking of width and thickness matching studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - a. Install solid blocking at 96-inch centers.
 - 2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
- F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable wall-framing system.

SECTION 05500 – METAL FABRICATIONS**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

- A. Items fabricated from iron and steel shapes, and plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems in other Sections of these Specifications.
 - 1. Fasteners.
 - 2. Protective primers and coatings.
 - 3. Grout for installation of materials and products specified herein.
 - 4. Prefabricated metal products specified herein.
 - 5. Steel framing and supports for mechanical and electrical equipment.
 - 6. Loose bearing and leveling plates.
 - 7. Steel weld plates and angles for casting into concrete not specified in other Sections.
 - 8. Metal ladders.
 - 9. Metal bollards.
 - 10. Loose steel lintels.
 - 11. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
 - 12. Metal Stairs.
- B. Related Sections include the following:
 - 1. Division Section 03300 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
 - 2. Division Section 04200 "Unit Masonry" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
 - 3. Division Section 06100 "Rough Carpentry" for metal framing anchors.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Material description and installation instructions for products.
 - 2. Shop Drawings: Layout and detail of each miscellaneous metal item shown and specified.
 - 3. Furnish setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete and masonry construction. Coordinate delivery of such items to Project site.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver iron and steel fabrications to the Project site and store to avoid damage and distortion of materials. Material damaged due to mishandling shall be replaced at no additional cost to the Owner.
- B. Identify pieces with suitable mark for easy location.
- C. Deliver products in their original wrappings or cartons clearly marked for identification and bearing manufacturers name, and model or part number if applicable. Store protected

from damage and the elements. Damaged and otherwise unsuitable materials when so determined, shall be immediately removed from the Project site.

PART 2 PRODUCTS

2.01 METAL MATERIALS

- A. Structural Steel: W-Shapes – ASTM A992. Other Shapes and Plates: ASTM A36.
- B. Steel Plates to be Bent or Formed Cold ASTM A203.
- C. Hot-rolled, Rail Carbon Steel Bars and Shapes: ASTM A499
- D. Cold-finished Steel Bars: ASTM A10.
- E. Steel Pipe: Welded or seamless, ASTM A53, black and hot dipped galvanized.
- F. Steel Tubing: Cold-formed ASTM A50 or hot-rolled ASTM A501.
- G. Galvanized Steel Sheets: ASTM A526.
- H. Aluminum Sheet, Alloy 6063 TS, thickness as indicated on detail.
- I. Stainless Steel Bars and Shapes: Type 304, QQ-S-763, ASTM A276
- J. Bolts and Nuts: ASTM A307, Grade A, galvanized.
- K. Welding Electrodes: AWS Specifications.
- L. Ferrous Metal Primer: SSPC 13-64; FS TT-P-86, Types II; FS TT-P-615
Type II as appropriate for the environmental conditions and compatible with finish painting systems specified.
- M. Galvanized Primer: FS TT-P-641d.
- N. Bituminous Paint Asphalt emulsion ASTM D1187.
- O. Hydraulic Cement: "Porok" (Hallemite Company) "Rocktite" (Hartline Products Co. Inc.); "Five Star Instant Grout" (U.S. Grout Corporation); or Dam-It" (Euclid Chemical Co.).

2.02 METAL FABRICATIONS

- A. General:
 - 1. Fabricate and assemble loose items in the shop and, if necessary, mark to ensure proper installation at the Project site. Disassemble for shipment only to the extent required by shipping limitations.
 - 2. Ease exposed edges of steel shapes.
 - 3. Join parts with hairline contact, flush and smooth with adjacent surfaces using concealed welds and fasteners where possible. Where exposed fastenings are unavoidable, countersink screws and bolts. Grind exposed weld areas smooth to match and blend with finished surfaces.
 - 4. Use hot-rolled steel bars, except where cold-rolled or cold finished arc shown or specified.
 - 5. Weld in accordance with the recommendations of the AWS.
- B. Gate Frame:
 - 1. Fabricate gates and posts from A500 steel tubes as detailed. All joint connections to be full welds, ground smooth. Provide pair of self-closing butts (minimum 3-1/2 x 1-1/2 inches), latch plate and hasp to permit use of padlock, cane bolt and sleeve.
- C. Cover at Gutter:
 - 1. Fabricate steel angle frame and cover plate as detailed. Acceptable manufacturers are:
 - a. Catch Basin grates: Neenah R-4880-A (square), R-1792FG (round)
 - b. Solid lids and angle frames: Neenah R-1883-G2A (square), R-1792FL (round).
 - c. Trench drain frame and grate: Neenah R-4999 DF, Type A grating, Type L frame, double bolt style; coordinate with drawings.
- D. Pit Steel:
 - 1. Steel plate around opening perimeter; see Structural Drawings.
 - 2. Pit opening steel shall be 1/4" thick galvanized steel, primed and painted as described in Division 9 - Painting.

- E. Bollards:
 - 1. Schedule 40 steel 6" diam. X 60" unless specified otherwise.
- F. Hand Rail:
 - 1. Steel pipe, welded with the following:
 - a. Top rail: As indicated on drawings.
 - b. Intermediate rail: As indicated on drawings.
 - c. Posts: As indicated on drawings.
- G. Miscellaneous Framing and Support:
 - 1. Provide miscellaneous steel framing and supports which are not a part structural steel framework as required to complete work.
 - 2. Fabricate miscellaneous units to sizes, shapes and profiles shown or if not shown, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
 - 3. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Except as otherwise shown, space anchors 24" o.c. and provide minimum anchor units of 1-1/4" x 1/4"x 8" steel straps.
- H. Loose Bearing and Leveling Plates:
 - 1. Provide loose bearing and leveling plates for steel items bearing on masonry and concrete construction, made flat, free from warps and twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required.
 - 2. Galvanize after fabrication.
- I. Miscellaneous Steel Trim:
 - 1. Provide shapes and sizes for profiles shown. Except as otherwise noted, fabricate units from structural steel shapes and plates and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible.
 - 2. Provide cutouts, fittings and anchorages as required for coordination of assembly and installation with other work.
- J. Loose Lintels:
 - 1. Provide loose structural steel lintels for openings in masonry walls unless otherwise detailed, including openings for mechanical and electrical work.
 - 2. Loose angle lintels and lintel beams shall be detailed for a minimum bearing of 1" per foot of span, but not less than 8", unless otherwise indicated.
- K. Rough Hardware:
 - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel iron shapes as required for framing and supporting wood work, and for anchoring or securing woodwork to concrete and other structures.
 - 2. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.03 PRIMING AND PROTECTIVE COATING

- A. Clean ferrous metal in accordance with applicable requirements of SSPC-SP1 (Solvent Cleaning) followed by cleaning with applicable requirements of SSPC-SP2 (Hand Tool Cleaning).
- B. Supply specified primer to ferrous metal surfaces by brush or spray to dry film thickness of 2 mils.
- C. Galvanize products as shown or specified in accordance with ASTM A123, A385 and A1223 as applicable.
- D. Paint galvanized surfaces with 1 (one) coat of specified primer, by brush or spray application.
- E. Paint miscellaneous metal work which is to be in contact with but not fully embedded in concrete and masonry with a heavy coat of bituminous paint. Also coat dissimilar metals

which are or will be in contact with one another with such paint. Coating shall not extend onto surfaces which will be exposed.

- F. Do not prime or paint sections to be welded in place until after the weld has been performed.
- G. Exposed pit opening steel and surrounding structural steel shall be primed and painted in accordance with Division 9 Painting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions under which metal fabrications are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting wherever taking field measurements before fabrication might delay work.
- B. Shop Assembly: Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- C. Furnish setting drawings, diagrams, templates, instruction and directions for installation of anchorages, such as concrete inserts, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete and masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

- A. General:
 - 1. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction, including threaded fasteners for concrete and masonry inserts, toggle bolts, throughbolts, lag bolts, wood screws and other connectors as required. Use of lead shield expansion anchors is prohibited.
 - 2. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry and similar construction.
 - 3. Fit exposed connections accurately together to form tight hairline joints. Weld connections which are not to be left as exposed joints, but cannot be shop welded because of shipping size limitation. Grind exposed joints smooth and touch-up shop paint coat and screwed field connections.
 - 4. Field Welding Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.
- B. Installing Bearing and Leveling Plates
 - 1. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
 - 2. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before

packing with grout. Use non-shrink grout.

- a. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

C. Installing Metal Bollards

1. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
2. Fill bollards solidly with concrete, mounding top surface slightly to shed water with a slick finish.

3.04 ADJUSTING AND CLEANING

- A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and galvanize, and touch-up exposed areas with same material as used for shop coatings. Apply by brush or spray as specified for shop coatings.

SECTION 05600 - MISCELLANEOUS METAL WORK**PART 1 GENERAL****1.01 Drawings and general provisions of the Contract, including General Conditions and Division 01 specification Sections, apply to this Section.****1.02 SUMMARY**

- A. This Section includes the following:
 - 1. Steel pipe railings.

1.03 PERFORMANCE REQUIREMENTS

- A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Steel: 72 percent of minimum yield strength.
- B. Structural Performance: Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Top Rails of Guards: downward.
 - b. Concentrated load of 200 lb applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 200 lb applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.04 SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain railing through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code—Steel."

PART 2 PRODUCTS**2.01 METALS, GENERAL**

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, Roller marks, rolled trade names, stains, discolorations, or blemishes.

2.02 STEEL AND IRON

- A. Pipe: ASTM A 53, Type F or Type S, Grade B, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads
 - 1. Provide galvanized finish for exterior installations and where indicated.
- B. Steel Bars: ASTM A 36.

2.03 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded
- B. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat.
 - 1. Use primer with a VOC content of 420 g/l (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM 18/19
 - b. ICI Devco Coatings; Catha-Coat 313.
 - c. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
 - d. Sherwin-Williams Company; Corothane I GalvaPac Zinc Primer
 - e. Tnemec Company, Inc.; Tneme-Zinc 90-97
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- D. Non-Shrink, Non-Metallic Grout: Factory-packaged, non-staining, non-corrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.04 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish and anchorage.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form work true to line and level with accurate angles and surfaces.
- D. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- E. Connections: Fabricate railings with welded connections, unless otherwise indicated.
- F. Welded Connections: Cope connections at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- G. Form changes in direction by radius bends of radius indicated.
- H. Form simple and compound curves by bending members in jigs to produce uniform curvature for each respective configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

2.05 FINISHES, GENERAL

- A. Comply with NSSMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.06 STEEL AND IRON FINISHES

- A. Galvanized Railings: Hot-dip galvanize exterior steel and iron railings after fabrication.
- B. Fill vent and drain holes that will be exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Printing: After galvanizing, thoroughly clean railings of grease, dirt, flux, and other foreign matter, and treat with metallic-phosphate process.
- D. Apply shop primer to prepared surfaces of railings, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification no. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete masonry.

PART 3 EXECUTION**3.01 INSTALLATION, GENERAL**

- A. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished -after fabrication.
 - 2. Set posts plumb within a tolerance of 1/16 inch 3 feet.

3.02 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in Part 2 "Fabrication" Article whether welding is performed in the shop or in the field.

3.03 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, non-metallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.

3.04 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing comply with ASTM A 780.

3.05 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

SECTION 06100 – ROUGH CARPENTRY**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Framing with dimension lumber.
 - 2. Framing with engineered wood products.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Wood blocking and nailers.
 - 5. Wood furring and grounds.
 - 6. Plywood backing panels.
- B. Related Sections include the following:
 - 1. Division 06 Section "Sheathing."
 - 2. Division 06 Section "Shop-Fabricated Wood Trusses."

1.03 DEFINITIONS

- A. Exposed Framing: Framing not concealed by other construction.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.
- C. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. SPIB: The Southern Pine Inspection Bureau.
 - 4. WCLIB: West Coast Lumber Inspection Bureau.
 - 5. WWPAA: Western Wood Products Association.

1.04 SUBMITTALS

- A. Product Data (If requested by Owner) For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preserved treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
 - 3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.05 QUALITY ASSURANCE

- A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.
- B. Fire retardant treated wood.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- B. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces.

PART 2 PRODUCTS**2.01 WOOD PRODUCTS, GENERAL**

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 3. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Engineered Wood Products: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
 - 1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPAC2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPAC31 with inorganic boron (SBX).
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 - 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 - 2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.

3. Wood framing members that are less than 18 inches above the ground in unexcavated areas.
4. Wood floor plates that are installed over concrete slabs-on-grade.

2.03 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWPAC20 (lumber) and AWPAC27 (plywood).
 1. Use Exterior type for exterior locations and where indicated.
 2. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
 3. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
- C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- D. Application: Treat items indicated on Drawings, and the following:
 1. Concealed blocking.
 2. Framing for non-load-bearing partitions.
 3. Framing for non-load-bearing exterior walls.
 4. Roof construction.
 5. Plywood backing panels.

2.04 DIMENSION LUMBER FRAMING

- A. Maximum Moisture Content: 19 percent.
- B. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade and any of the following:
 1. Hem-fir (north); NLGA.
 2. Mixed southern pine; SPIB.
 3. Spruce-pine-fir; NLGA.
 4. Northern species; NLGA.
- C. Exterior and Load-Bearing Walls: Construction or No. 1 grade and any of the following:
 1. Hem-fir (north); NLGA.
 2. Southern pine; SPIB.
 3. Douglas fir-larch; WCLIB or WWPA.
- D. Ceiling Joists (Non-Load-Bearing): Construction or No. 2 grade and any of the following:
 1. Hem-fir (north); NLGA.
 2. Southern pine; SPIB.
 3. Douglas fir-larch; WCLIB or WWPA.
- E. Joists and Other Framing Not Listed Above: Construction or No. 2 grade and any of the following:
 1. Hem-fir (north); NLGA.
 2. Southern pine; SPIB.
 3. Douglas fir-larch; WCLIB or WWPA.

2.05 ENGINEERED WOOD PRODUCTS (As shown on Drawings)

- A. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
 1. Manufacturers: Subject to compliance with requirements, provide products by

- one of the following:
 - a. Weyerhaeuser Company (I Level)
 - b. Boise Cascade Corporation.
 - c. Georgia-Pacific.
 - d. Louisiana-Pacific Corporation.
- 2. Extreme Fiber Stress in Bending, Edgewise: 2600 psi for 12-inch nominal depth members.
- 3. Modulus of Elasticity, Edgewise: 1,800,000 psi.
- B. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559 and containing no urea formaldehyde.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Weyerhaeuser Company (I Level)
 - 2. Extreme Fiber Stress in Bending, Edgewise: 2900 psi for 12-inch nominal depth members.
 - 3. Modulus of Elasticity, Edgewise: 2,200,000 psi.
- C. Wood I-Joists: Prefabricated units, I-shaped in cross section, made with solid or structural composite lumber flanges and wood-based structural panel webs, let into and bonded to flanges. Provide units complying with material requirements of and with structural capacities established and monitored according to ASTM D 5055.
 - 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - a. Weyerhaeuser Company
 - b. I-Level Truss Joist Commercial
 - 2. Provide I-joists manufactured without urea formaldehyde.
 - 3. Web Material: Either oriented strand board or plywood, complying with DOC PS 1 or DOC PS 2, Exposure 1.
 - 4. Structural Properties: Provide units with depths and design values not less than those indicated.
 - 5. Provide units complying with APA PRI-400, factory marked with APA trademark indicating nominal joist depth, joist class, span ratings, mill identification, and compliance with APA standard.

2.06 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Furring.
 - 5. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:
 - 1. Hem-fir (north); NLGA.
 - 2. Mixed southern pine; SPIB.
 - 3. Spruce-pine-fir; NLGA.
 - 4. Northern species; NLGA.
- C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
 - 1. Mixed southern pine, No. 2 grade; SPIB.
 - 2. Hem-fir or hem-fir (north), Construction or 2 Common grade; NLGA, WCLIB, or WWP.
 - 3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common grade;

NeLMA, NLGA, WCLIB, or WWPA.

- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.07 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.08 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153 of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.09 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Simpson Strong-Tie Co., Inc.
- B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of products of manufacturer listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 coating designation.
 - 1. Use for interior locations where stainless steel is not indicated.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 1. Use for exterior locations and where indicated.
- E. Joist Hangers: U-shaped joist hangers with 2-inch long seat and 1-1/4-inch wide nailing flanges at least 85 percent of joist depth.
 - 1. Thickness: 0.062 inch.
- F. I-Joist Hangers: U-shaped joist hangers with 2-inch long seat and 1-1/4-inch wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.

1. Thickness: 0.062 inch.
- G. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
 1. Strap Width: 2 inches.
 2. Thickness: 0.062 inch.
- H. Bridging: Rigid, V-section, nail-less type, 0.050 inch thick, length to suit joist size and spacing.
- I. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post one inch above base and with 2-inch minimum side cover, socket 0.062 inch thick, and standoff and adjustment plates 0.108 inch thick.
- J. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
 1. Width: 3/4 inch.
 2. Thickness: 0.062 inch.
 3. Length: 16 inches.
- K. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches wide by 0.050 inch thick by 36 inches long.
- L. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
 1. Bolt Diameter: 5/8 inch.
 2. Width: 2-1/2 inches.
 3. Body Thickness: 0.138 inch.
 4. Base Reinforcement Thickness: 0.239 inch.
- M. Wall Bracing: T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches wide by 9/16 inch deep by 0.034 inch thick with hemmed edges.
- N. Wall Bracing: Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch thick with hemmed edges.

2.10 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- D. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.
- E. Do not splice structural members between supports, unless otherwise indicated.
- F. Provide blocking and framing as indicated and required to support facing materials, fixtures, specialty items, and trim. Provide metal clips for fastening gypsum board at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

- G. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- H. Comply with AWWA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- I. Securely attach rough carpentry work to substrate by anchoring as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- J. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.02 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.03 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood Paneling: Install 1-by-3-inch nominal size furring horizontally and vertically at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

3.04 WALL AND PARTITION FRAMING INSTALLATION

- A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction, unless otherwise indicated.
 - 1. For exterior walls, provide 2-by-6-inch nominal size wood studs spaced 16 inches o.c., unless otherwise indicated.
 - 2. For interior partitions and walls, provide 2-by-6-inch or 2-by-4-inch nominal size wood studs spaced 16 inches o.c., unless otherwise indicated.
 - 3. Provide continuous horizontal blocking at midheight of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.
- B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.

- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
 - 1. Unless otherwise noted on drawings, for load-bearing walls, provide double-jamb studs for openings 60 inches and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated or, if not indicated, according to recommendations of AFPA's "Manual for Wood Frame Construction."

3.05 CEILING JOIST FRAMING INSTALLATION

- A. General: Install ceiling joists with crown edge up and support ends of each member with not less than 1-1/2 inches of bearing on wood or metal, or 3 inches on masonry. Attach floor joists as follows:
 - 1. Where supported on wood members, by toe nailing or by using metal framing anchors.
 - 2. Where framed into wood supporting members, by using wood ledgers as indicated or, if not indicated, by using metal joist hangers.
- B. Frame openings with headers and trimmers supported by metal joist hangers; double headers and trimmers where span of header exceeds 48 inches.
- C. Do not notch in middle third of joists; limit notches to one-sixth depth of joist, one-third at ends. Do not bore holes larger than 1/3 depth of joist; do not locate closer than 2 inches from top or bottom.
- D. Provide solid blocking of 2-inch nominal thickness by depth of joist at ends of joists unless nailed to header or band.
- E. Lap members framing from opposite sides of beams or partitions not less than 4 inches or securely tie opposing members together. Provide solid blocking of 2-inch nominal thickness by depth of joist over supports.
- F. Anchor members paralleling masonry with 1/4-by-1-1/4-inch metal strap anchors spaced not more than 96 inches o.c., extending over and fastening to 3 joists. Embed anchors at least 4 inches into grouted masonry with ends bent at right angles and extending 4 inches beyond bend.
- G. Provide bridging of type indicated below, at intervals of 96 inches o.c., between joists.
 - 1. Diagonal wood bridging formed from bevel-cut, 1-by-3-inch nominal size lumber, double-crossed and nailed at both ends to joists.
 - 2. Steel bridging installed to comply with bridging manufacturer's written instructions.

3.06 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

SECTION 06160 - SHEATHING**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Wall sheathing.
 - 2. Roof sheathing.
 - 3. Building wrap.
 - 4. Flexible flashing at openings in sheathing.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for plywood backing panels.

1.03 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
 - 4. For building wrap, include data on air-/moisture-infiltration protection based on testing according to referenced standards.

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack plywood and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS**2.01 WOOD PANEL PRODUCTS, GENERAL**

- A. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.
- B. Thickness: As needed to comply with requirements specified, but not less than the thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

2.02 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWWA C9.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood, unless otherwise indicated and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.03 WALL SHEATHING

- A. Plywood Wall Sheathing: Interior with exterior glue, Exposure 1, APA Rated sheathing.
 - 1. Span Rating: Not less than 32/16.
 - 2. Nominal Thickness: Per Drawings

2.04 ROOF SHEATHING

- A. Plywood Roof Sheathing: Interior with exterior glue, Exposure 1, APA Rated sheathing.
 - 1. Span Rating: Not less than 32/16.
 - 2. Nominal Thickness: Per Drawings.

2.05 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
 - 1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

2.06 WEATHER-RESISTANT SHEATHING PAPER

- A. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke- developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized, and acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. DuPont (E. I. du Pont de Nemours and Company); Tyvek CommercialWrap.
 - b. Owner approved equal.
 - 2. Water-Vapor Permeance: Not less than 200 g through 1 sq. m of surface in 24 hours per ASTM E 96, Desiccant Method (Procedure A).
 - 3. Allowable UV Exposure Time: Not less than three months.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.07 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.
 - 1. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - b. Grace Construction Products, a unit of W. R. Grace & Co.; Vycor Plus Self-Adhered Flashing.
 - c. MFM Building Products Corp.; Window Wrap.
 - d. Polyguard Products, Inc.; Polyguard 300.
 - e. Protecto Wrap Company; BT-20 XL.
- C. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.

2. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's "Uniform Building Code."
- D. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.02 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30S, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 1. Wall and Roof Sheathing:
 - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
 - b. Screw to cold-formed metal framing.
 - c. Space panels 1/8 inch apart at edges and ends.

3.03 WEATHER-RESISTANT SHEATHING-PAPER INSTALLATION

- A. General: Cover sheathing with weather-resistant sheathing paper as follows:
 1. Cut back barrier 1/2 inch on each side of the break in supporting members at Expansion or control joint locations.
 2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap, unless otherwise indicated.
- B. Building Wrap: Comply with manufacturer's written instructions.
 1. Seal seams, edges, fasteners, and penetrations with tape.
 2. Extend into jambs of openings and seal corners with tape.

3.04 FLEXIBLE FLASHING INSTALLATION

- A. Apply flexible flashing where indicated to comply with manufacturers written instructions.
 1. Prime substrates as recommended by flashing manufacturer.
 2. Lap seams and junctures with other materials at least 4 inches, except that at flashing flanges of other construction, laps need not exceed flange width.
 3. Lap flashing over weather-resistant building wrap at bottom and sides of openings.
 4. Lap weather-resistant building wrap over flashing at heads of openings.
 5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

SECTION 06175 OPEN WEB TRUSSES**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This work includes the complete furnishings and installation of open-web trusses, as shown on Drawings herein specified and necessary to complete the Work
- B. This Section includes the following:
 - 1. Wood roof trusses.
 - 2. Wood truss bracing.
- C. Related Sections include the following:
 - 1. Division 06 Section "Sheathing" for roof sheathing.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide open web trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
 - 1. Design Loads: As indicated on Drawings.
 - 2. Maximum Deflection Under Design Loads: Vertical deflection of 1/240 of span.
- B. Delegated Design: Design open-web trusses, including comprehensive load and reaction engineering calculation analysis, Shop Drawings, and other structural data by qualified professional engineer, using performance requirements and design criteria indicated.
- C. Seismic Performance: Structural open web trusses shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1.04 FIRE AND SOUND RATINGS

- A. Fire and sound ratings are to be established in accordance with assemblies detailed in ICC ES Legacy Report No. PFC-4354, or in the Directory of Listed Products published by Intertek Testing Services.

1.05 SUBMITTALS

- A. Product Data:
 - 1. Include data on lumber, adhesives, fabrication, and protection.
 - 2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. For connectors, include installation instructions
 - 4. For metal truss accessories and fasteners.
- B. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer. Show fabrication and installation details for trusses.
 - 1. Shop Drawings showing layout and detail necessary for determining fit and placement in the building shall be provided.
 - 2. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.

3. Indicate sizes, stress grades, and species of lumber.
4. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
6. Show splice details and bearing details.
7. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 QUALITY ASSURANCE

- A. Each of the open-web trusses shall be identified by a stamp indicating the truss series, ICC ES evaluation report number, manufacturer's name, plant number, date of fabrication, and the independent inspection agency's logo.
- B. Open-web truss products shall be designed and manufactured to the standards set forth in the ICC ES Legacy Report No. PFC-4354, unless otherwise noted
- C. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Owner and authorities having jurisdiction.
- D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and "Supplement."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store open-web trusses to comply with recommendations of TPI HIB
 1. Store open-web trusses vertical position, off of ground, and adequately supported to prevent lateral bending, in accordance with manufacturers written recommendations.
 2. Protect open-web trusses from weather by covering with waterproof sheeting, securely anchored.
 3. Provide for air circulation around stacks and under coverings.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.
- C. If stored prior to installation, shall be stored in a vertical position and protected from the weather. They shall be handled with care so they are not damaged

1.08 COORDINATION

- A. Time delivery and erection of open-web trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

1.09 WARRANTY

- A. Products delivered shall be free from manufacturing errors or defects in workmanship and material. Open-web trusses, when correctly installed and maintained, shall be warranted to perform as designed for the normal and expected life of the building structure.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Materials shall comply with ICC ES Legacy Report No. PFC-4354. Chord members, web members, connecting pins and bearing hardware/attachments shall be of material and size as required by design.

2.02 DIMENSION LUMBER

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Provide dressed lumber, S4S.
 - 4. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- B. Grade and Species: Provide visually graded dimension lumber for truss chord and web members, of not less than the following grade and the following species:
 - 1. Grade for Chord Members: No. 2 or better.
 - 2. Grade for Web Members: No. 3 or better.
 - 3. Species: Southern pine; SPIB, Douglas fir-larch; WCLIB or WWPA, Spruce-Pine-Fir; NLGA.
- C. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for both top and bottom chords.
- D. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Division 06 Section "Rough Carpentry."

2.03 TOLERANCES

- A. Length Bearing to Bearing: +/- 1/8-inch for trusses up to 30 feet, +/- 1/4-inch for trusses more than 30 feet
- B. Depth: +/- 1/8-inch
- C. Camber:
 - 1. Trusses up to 30 feet: +/- 1/8-inch
 - 2. Trusses greater than 30 feet to 60 feet: +/- 3/8-inch
 - 3. Trusses greater than 60 feet to 120 feet: +/- 1/2-inch

2.04 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- B. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
 - 1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

PART 3 EXECUTION**3.01 INSTALLATION**

- A. Open-web trusses shall be installed in accordance with the plans, and any shop

drawings and installation requirements. Temporary construction loads that cause stresses beyond design limits are not permitted.

1. Open-web trusses shall be designed to fit the dimensions and loads indicated on approved shop drawings.
- B. Provide bracing to keep the trusses straight and plumb as required, and to assure adequate lateral support for the individual trusses and the entire system until the sheathing material has been applied
- C. Fabrication and/or cutting shall not proceed until the Owner has approved the submittal package.
- D. Install wood trusses only after supporting construction is in place and is braced and secured.
- E. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.
- F. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- G. Install and brace trusses according to TPI recommendations and as indicated.
- H. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- I. Space trusses as indicated on Drawings, adjust and align trusses in location before permanently fastening.
- J. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.
- K. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
 1. Install bracing to comply with Division 06 Section "Rough Carpentry."
- L. Install wood trusses within installation tolerances in TPI 1.
- M. Do not cut or remove truss members.
- N. Replace wood trusses that are damaged or do not meet requirements.
 1. Do not alter trusses in field.

3.02 REPAIRS AND PROTECTION

- A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

SECTION 06200 FINISH CARPENTRY**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SECTION INCLUDES

- A. Millwork fabrication and installation.
- B. Miscellaneous products specified herein.
- C. Installation of products specified elsewhere.
- D. Plastic laminate products and installation.

1.02 RELATED SECTIONS

- A. Section 06100 - Rough Carpentry.
- B. Section 07900 - Sealants.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Descriptions, installation and operating instructions of completely assembled manufactured items other than wood millwork fabricated under this Section.
 - 2. Shop Drawings: Show plans, elevations and details of all wood millwork, indicating materials, species of wood, applied finishes, matching of panels, arrangement, profiles, thicknesses, construction fastenings blocking clearances, assembly and erection details, built-in hardware and necessary connections to other work.
 - 3. Samples: Swatches of plastic laminate and mouldings selected.

1.04 QUALITY ASSURANCE

- A. Custom woodwork shall comply with the applicable requirements of the AWI Quality Standards established by the Architectural Woodwork Institute.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Do not deliver materials until painting, wet work, grinding, and similar operations which could damage, soil and deteriorate materials, have been completed in installation areas. If, due to unforeseen circumstances, materials must be stored in other than installation areas, store only in areas which meet the requirements specified for installation areas.
- C. Receive and store finish hardware. Properly sort, tag, and file tags.

1.06 PROJECT CONDITIONS

- A. Do not install finish carpentry work until interior concrete and masonry work, and other wet operations are complete, the building is adequately ventilated, and proper temperature and humidity conditions can be maintained during and after installation.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Hardwood lumber for a painted finish shall be clear with no visible defects which must be fill before painting. May be un-selected for color and grain.
- B. Hardwood lumber for transparent finish shall be clear, with no visible defects, and well matched for color and grain.
 - 1. Interior exposed millwork and trim shown on the Drawings as hardwood shall be plain sliced Red Oak.
 - 2. Trim Profiles: Door and window casings, and other wood trim molding patterns selected from industry standards and as shown on the Drawings.
- C. Softwood lumber shall be Ponderosa Pine, Idaho White Pine, Sugar Pine or Northern White Pine. Softwood lumber shall conform to the requirements of Product Standards PS 20-70.
- D. Hardwood plywood and veneer for transparent finish shall be clear, with no visible defects, and well matched for color and grain, conforming to Product Standard PS 51-71. Exposed veneer shall be plain sliced Red Oak.
- E. Softwood Plywood: Product Standards PS 1-83.
- F. Plastic Laminate: General purpose Type GP 50, complying with NEMA Publication No. LD-3, including latest revisions. Refer to architectural drawings for specific selection.
- G. Sanitary Paneling(FRP): Fiberglass reinforced polyester panels, meeting Class III Fire Resistance Rating, complying with USDA and FDA requirements. See drawings.
 - 1. Provide manufacturer's standard vinyl molding strips, suitable for board use.
 - 2. Mold and mildew resistant adhesive for securing sanitary paneling as recommended by the paneling manufacturer.
- H. Stainless steel outside corner guard: Snap on corner guard with retainer (22 ga.)

2.02 FABRICATION

- A. In general millwork shall be fabricated in the shop in largest units possible and delivered to the Project site for installation. Where necessary to fit units at the Project site, allowance shall be made for cutting and fitting.
- B. Not all details of millwork are shown on the Drawings. The fabricator shall utilize the most advantageous manufacturing processes to achieve the quality of millwork indicated herein by reference to AWI Quality Standards.
- C. Fabricate standing and running trim in accordance with AWI Section 300, Custom Grade, including closet hook strips and miscellaneous trim.
- D. Fabricate plastic laminate veneered cabinets, tops, and curbs in accordance with AWI, Section 400, Premium Grade.
 - 1. Cabinet construction shall conform to flush overlay design.
 - 2. Tops, backsplashes, and returns where shown shall be square edge design.
 - 3. Balancing or back-up sheet requirements specified in AWI for plastic laminate veneer.
- E. Plastic laminate veneered butt all joints tight. Textured surface direction shall match with each sheet.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine the areas and conditions under which finish carpentry work is to be performed and notify the Contractor in writing of conditions detrimental to the proper and timely

completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Verify measurements at the building and provide necessary closures and trim to fit the items enclosing walls. Provide other trades with information necessary for proper completion of related work.
- B. Condition work to average prevailing humidity conditions in installation areas prior to installing.

3.03 INSTALLATION

- A. General:
 - 1. Work shall be installed by experienced finish carpenters only. Work shall be erected plumb, true and square in a substantial manner. Finished work shall be neatly installed, free of slivers, open joints, hammer and tool marks. Blind nail finished work insofar as possible, and set surface nails.
 - 2. Woodwork: Install, plumb, level, true and straight with no distortions. Shim as required using concealed shims. Cut to fit unless specified to be shop-fabricated or shop-cut to exact size. Where woodwork abuts other finished work, scribe and cut for accurate fit. Before making cutouts, drill pilot holes at corners. Distribute defects allowed in the quality grade specified to the best over-all advantage, when installing job assembled woodwork items.

3.04 INSTALLATION OF STANDING AND RUNNING TRIM

- A. Trim and Mouldings: Install in single, un-jointed lengths for openings and for runs less than 10 feet. For longer runs, use only 1 (one) piece less than 10 feet in any straight run. Stagger joints in adjacent members. Cope at returns and mitre at corners.
 - 1. Attach securely in place with uniform joints providing for thermal and building movements.
 - 2. Nailing: Blind nail where possible. Use fine finishing nails where exposed. Set exposed nail heads for filling.
 - 3. Anchoring: Secure woodwork to anchors or blocking built-in or directly attached to substrates.
- B. Preparation for Finish: Clean woodwork and fill nail holes in preparation for finishes specified under Painting Sections of these Specifications. Where woodwork is to receive a transparent finish, use matching wood filler.

3.05 INSTALLATION OF COUNTERTOPS

- A. Attach countertops securely to blocking and provide cutouts for plumbing fixtures and in-counter soap dispensers, if any. Smooth cut edges of cutouts and coat with waterproof coating or adhesive. Scribe tops to walls.

3.06 INSTALLATION OF SANITARY PANELING

- A. Secure paneling to walls as indicated on Drawings. Apply vinyl molding strips to raw edges of paneling. Butt joints at intersecting walls and apply sealant bead full height of joints. In areas of heavy traffic as determined by the Owner's representative, install stainless steel outside corner guards.

3.07 INSTALLATION OF FINISH DOOR HARDWARE

- A. Apply finish hardware as recommended by hardware manufacturer and as required. Fit lock and latch sets in their respective doors and remove before finishing of doors. Reinstall hardware after finishing of doors is completed. Upon completion, adjust and lubricate hardware for proper operation.
- B. Instruct Owner's personnel in the proper adjustment and maintenance of hardware.

3.08 MISCELLANEOUS INSTALLATION

- A. Install such items as toilet partitions, signage, fire extinguishers, toilet room accessories, miscellaneous specialties, and other items furnished by others requiring fasteners, cutting, trimming, and scribing of furnished materials or finished substrate.
 - 1. Install plumb, level, true and straight.
 - 2. Install according to manufacturer's printed instructions and in accordance with recommendations under the respective Sections.

SECTION 06240 CABINET WORK**PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Includes the furnishing of all materials, labor, tools, and equipment required for the installation of the laminate plastic covered cabinet work for the project as herein specified and indicated on the drawings.

1.02 RELATED SECTIONS

- A. Section 06100 Carpentry-Millwork
- B. Section 09250 Gypsum Wallboard System
- C. Section 09920 Interior Painting

1.03 REFERENCE STANDARDS

- A. FS-L-P-508F - Plastic Sheet, Laminated, Decorative and Non-Decorative
- B. FS MMM-A-130A - Adhesive, Contact
- C. PS 1 - Construction and Industrial Plywood
- D. PS 20 - American Softwood Lumber Standard
- E. PS51 - Hardwood and Decorative Plywood
- F. PS 58 - Basic Hardwood
- G. NFPA National Forest Products Association National Design Specification for Stress Grade Lumber and its Fastening.

1.04 SUBMITTALS

- A. Shop Drawings, Samples, Mfg. Data, Color Selections - Submit shop drawings, samples, manufacturer's data and color samples of cabinet millwork in accordance with Section 01340.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable Products
 - 1. Bellair Series Type "P" as mfgd. by St. Charles Mfg. Co.
 - 2. Nevamar as mfgd. by Midway Industrial Park, Adenton, Maryland 21113.
 - 3. R.F. Creson & Co. (cabinet work), Memphis, TN
 - 4. Saunders Mfg. Co., (cabinet work), Memphis, TN
 - 5. Ken-Rich Millwork Mfg. Co., Memphis, TN
 - 6. Others approved as meeting these specifications.
- B. Substitutions: Items of same function and performance are acceptable in conformance with Section 01600.

2.02 MATERIAL AND CONSTRUCTION

- A. Tops and splash backs shall be 1/16" laminate plastic as manufactured by Wilson Art or approved as meeting these specifications.

- B. All parts are factory prefinished. Flush fronts overlap ends. Cabinet body panel joints are assembled with specially designed male and female nickel plated hardware applied so any panel or part may be replaced by disengaging hardware and removing sheet metal screws from back of cabinet. All end panels are of flush construction finished in pattern matching fronts. All exposed panel edges have extruded, shock-proof, ethyl-cellulose T-molding applied to grooved edge. Cabinet backs are rigidly screwed into rabbeted ends with sheet metal screws 1-1/4" long.
- C. Doors - 1/2" thick core, veneered on both sides with high-pressure plastic laminate with edges sealed with shock-proof T-molding.
- D. Drawers - Fronts are 1/2" thick core, veneered on both sides with textured high-pressure plastic laminate with all edges sealed with shock-proof T-molding. Drawer sides, inner fronts, and backs are 1/2" core veneered with matching high pressure plastic cabinet liner. All exposed edges are sealed with T-molding. Drawer bottoms are 1/8" hardboard core veneered with impervious textured Beige Scrim high-pressure cabinet liner. Drawers glide on plated steel slides with nylon, ball bearing rollers with positive stop. Drawers are easily manufactured for cleaning and have rubber bumpers to eliminate noise. All as manufactured by K & V hardware supplier.
- E. Cabinet tops, bottoms, ends and backs shall be 1/2" thick core, veneered both sides with matching high-pressure plastic cabinet liner or phenolic balancing sheet. All exposed edges sealed with shock-proof extruded T-edge.
- F. Shelves - 1/2" thick core, veneered both sides with matching high pressure cabinet liner. Upper and full height cabinet shelves are adjustable on 1/2" centers. Base cabinet shelves are adjustable on 1-1/2" centers.
- G. Recessed toe space - Integral 4" high, 3" deep toe space surfaced with textured black plastic laminate.

2.03 FINISH

- A. All cabinets have exposed surface covered with textured high pressure laminates. All cabinet fronts are high pressure .035" thick textured melamine vertical surfacing laminate in accordance with NEMA standards. Cabinet interiors and ends are surfaced in matching high pressure plastic cabinet liner. Unexposed outside surfaces are covered with a balancing sheet of phenolic, moisture-resistant backing material. Color as selected.

2.04 HARDWARE

- A. Provide all required hardware.
- B. Finish shall be chrome.
- C. All hardware shall be K & V or approved by Owner. Submit sample.

2.05 LAMINATE PLASTIC COUNTER AND BASE CABINETS

- A. Furnish and install laminate plastic counter and base cabinets, as detailed. Provide end and backsplash on countertops. Secure to wall framing with bolts and washers.
- B. Color of laminate plastic as selected by Owner.
- C. Provide cut out for sink, etc., all as required.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set and secure cabinet work and finish carpentry items in place rigid, plumb and square.
- B. Use purpose designed fixture attachments for wall mounted components.
- C. Use threaded steel concealed joint fasteners to align and secure adjoining cabinet units, countertops and base cabinets.
- D. Permanently fix cabinet and counter bases to floor using appropriate angles and anchorages.
- E. Carefully scribe cabinet work which is against other building materials, leaving gaps of 1/32" maximum. Do not use additional overlay for this purpose.
- F. Install and adjust cabinet hardware to insure smooth and correct operation. All cabinet hardware furnished by this section.
- G. Sink, faucets, trap, etc., furnished and installed by Section 15400.

SECTION 06640 - PLASTIC PANELING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section includes glass-fiber reinforced plastic (FRP) wall paneling and trim accessories.
- B. Related Sections:
 - 1. Division 06 Section "Rough Carpentry" for wood furring for installing plastic paneling.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain plastic paneling and trim accessories from single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
 - 3. Testing Agency: Acceptable to authorities having jurisdiction.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install plastic paneling until spaces are enclosed and weather-tight and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Allow material to adjust to room temperature (min. 24 hours) prior to beginning the installation: maintain an environment of 65°F - 75°F
- C. Do not store or stand panels on end.

1.5 WARRANTY

- A. Contractor shall guarantee that the materials and application fulfills all conditions as stated in these specifications. Should any workmanship or materials covered by these specifications be proven defective within the guarantee period, of 5 years, Contractor shall repair or replace the workmanship and materials without charge to Owner.
- B. Any deviation from this specification shall be approved in writing by Company. Failure of Contractor to consult with Owner representative to clarify any item in the specification will in no way relieve the Contractor of his responsibility for satisfactory compliance with these specifications.

PART 2 PRODUCTS**2.0 PLASTIC SHEET PANELING**

- A. FRP: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. **AS NOTED ON FINISH LEGEND**
 - 2. Nominal Thickness: Not less than 0.12 inch.
 - 3. Surface Finish: **AS NOTED ON FINISH LEGEND**
 - 4. Color: **AS NOTED ON FINISH LEGEND**
 - 5. Location: **AS NOTED ON FINISH SCHEDULE AND INTERIOR ELEVATIONS**
- B. Pre-laminated wall panels: square edged on 1/4" thick substrate.
 - 1. Manufacturer: Construction Specialties Group. Contact: 800-233-8493
 - 2. Nominal thickness of Acrovyn laminate: .060" excluding substrate.
 - 3. Surface Finish: Pebblette
 - 4. Color: Spectrum Red 845
 - 5. Location: Bay area wainscote 40" high.

2.1 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard two-piece, snap-on vinyl extrusions designed to cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
 - 1. Color: White.
- B. Exposed Fasteners: Nylon drive rivets recommended by panel manufacturer.
- C. Concealed Mounting Splines: Continuous, H-shaped aluminum extrusions designed to fit into grooves routed in edges of factory-laminated panels and to be fastened to substrate.
- D. Adhesive: As recommended by plastic paneling manufacturer.
 - 1. VOC Content: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants."
 - 1. VOC Content: 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Remove wallpaper, vinyl wall covering, loose or soluble paint, and other materials that might interfere with adhesive bond.
- B. Prepare substrate by sanding high spots and filling low spots as needed to provide flat, even surface for panel installation.
- C. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
- D. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- E. Lay out paneling before installing. Locate panel joints so that trimmed panels at corners are not less than 18 inches wide.

1. Mark plumb lines on substrate at panel joint with trim accessories locations for accurate installation.
2. Locate panel joints with trim accessories to allow clearance at panel edges according to manufacturer's written instructions.

3.2 INSTALLATION

- A. Install plastic paneling according to manufacturer's written instructions.
 1. Maintain panel orientation throughout the entire installation.
 2. Wipe the back of the wall panel with a clean, damp cloth before installation, to remove any dust and dirt.
 3. Wipe the wall to remove any dust or dirt.
- B. Install panels in a full spread of adhesive. Follow manufacturer's recommendations for adhesive material and application methods.
- C. Install trim accessories with adhesive and nails. Do not fasten through panels.
- D. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
- E. Maintain uniform space between panels and wall fixtures. Fill space with sealant.
- F. Maintain uniform space between adjacent panels and between panels and floors, ceilings, and fixtures. Fill space with sealant.
- G. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

3.3 CLEANING

- A. Immediately remove any adhesive that may have accidentally gotten on the panel using cleaners recommended by the manufacturer of the panel and adhesive.
- B. Do not use Methyl Ethyl Ketone (MEK) or any similar solvents to clean FRP or Pre-laminated Wall Panel surfaces.
- C. Do not use Scotch-Brite pads, steel wool or similar cleaning pads on FRP or Pre-laminated Wall Panels.

SECTION 07132 - PRE-APPLIED SHEET MEMBRANE WATERPROOFING**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. The Work of this Section includes, but is not limited to, "Preprufe 300R" pre-applied sheet membrane waterproofing that forms an integral bond to poured concrete for the following applications:
 - 1. Horizontal Applications: Membrane applied on prepared subbase prior to placement of concrete slabs.
- B. Related Section:
 - 1. Division 03 Section "Concrete Formwork"
 - 2. Division 03 Section "Cast-in-Place Concrete"
 - 3. Division 07 Section "Self-Adhering Sheet Waterproofing"

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: SUBMITTAL NOT REQUIRED BY ARCHITECT. PROVIDE DOCUMENTS TO VIOC Construction Manager if required. Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- C. Samples: Manufacturer's membrane samples
- D. Qualification Data: For Installer.
- E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: A firm which has at least 3 years' experience in work of the type required by this section.
- B. Materials: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
- C. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- D. Schedule Coordination: Schedule work such that membrane will not be left exposed to weather for longer than recommended by the manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

1.5 PROJECT CONDITIONS

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

1.6 WARRANTY

- A. Special Manufacturer's Warranty: Sheet Membrane Waterproofing: Provide written five year material warranty issued by the membrane manufacturer upon completion of work
- B. Special Installer's Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.
 - 1. Warranty includes removing and reinstalling waterproofing membrane and affected areas.

PART 2- PRODUCTS

2.0 WATERPROOFING SYSTEM PRODUCTS

- A. Pre-Applied Integrally Bonded HDPE Sheet Waterproofing Membrane for vertical or horizontal application: PREPRUFE® 300R Plus Membrane [or PREPRUFE® 300R Plus LT Membrane for application temperatures between 25°F (-4°C) and 60°F (+16°C)] as manufactured by GCP Applied Technologies, a 1.2mm (0.046 in) nominal thickness composite sheet membrane consisting of 0.8 mm (0.030 in.) of high density polyethylene film, a pressure-sensitive adhesive and a trafficable weather resistant coating. The membrane shall be supplied in a kick-out roll orientation and shall have no release liner to reduce waste onsite. The membrane shall form an integral, adhesive and permanent bond to poured concrete to prevent water migration at the interface of the membrane and structural concrete and shall include dual adhesive ZipLap™ seam technology to complete side laps and secure adjacent sheets. Provide membrane with the following physical properties:

NOTE: PREPRUFE® 300R Plus and PREPRUFE® 300 R Plus LT can both be installed at temperatures 25°F (-4°C) and above. For temperatures 25°F (-4°C) to 40°F (4°C) the use of PREPRUFE® LT Tape is recommended at all side laps when using PREPRUFE® 300R Plus. Alternatively, contractors may elect the use of PREPRUFE® 300R Plus LT, which does not require the use of PREPRUFE® LT Tape at side laps in temperature ranges 25°F (-4°C) to 40°F (4°C). For this reason, GCP Applied Technologies suggests that both products be incorporated into the specification.

PHYSICAL PROPERTIES FOR PREPRUFE® 300R Plus (or 300R Plus LT) MEMBRANE:

Property	Test Method	Typical Value
Color	NA	White with Yellow and Blue Zip Strips in the Side Lap Area
Thickness	ASTM D 3767 Method A	0.046 in. (1.2 mm) nominal

Property	Test Method	Typical Value
Lateral Water Migration Resistance	ASTM D 5385 Modified ¹	Pass at 231 ft (71m) of hydrostatic head pressure
Low Temperature Flexibility	ASTM D 1970	Unaffected at -20°F (-29°C)
Resistance to Hydrostatic Head	ASTM D 5385 Modified ²	231 ft (71m)
Elongation	ASTM D 412 Modified ³	400%
Tensile Strength, film	ASTM D 412	4,000 psi (27.6 MPa)
Crack Cycling at -9.4°F (-23°C), 100 Cycles	ASTM C 836	Unaffected, Pass
Puncture Resistance	ASTM E 154	200 lbs (890 N)
Peel Adhesion to Concrete	ASTM D 903 Modified ⁴	5.0 lbs/in. (880 N/m)
Lap Peel Adhesion	ASTM D 1876 Modified ⁵	8.0 lbs/in. (1408 N/m)
Permeance to water vapor transmission	ASTM E 96 Method B	0.01 perms (0.6 ng/Pa x s x m ²)

Footnotes:

1. Lateral water migration resistance is tested by casting concrete against membrane with a hole and subjecting the membrane to hydrostatic head pressure with water. The test measures the resistance of lateral water migration between the concrete and the blind side waterproofing membrane. A hydrostatic head pressure of 71 m (231 ft) of water is the limit of the apparatus.
2. Hydrostatic head tests are performed by casting concrete against the membrane with a lap. Before the concrete sets a 3 mm (0.125 in.) spacer is inserted perpendicular to the membrane to create a gap. The cured block is placed in a chamber where water is introduced to the membrane surface up to a head of 71 m (231 ft) of water which is the limit of the apparatus.
3. Elongation of membrane is run at a rate of 50 mm (2 in.) per minute.
4. Concrete is cast against the protective coating surface of the membrane and allowed to cure (7 days minimum). Peel adhesion of membrane to concrete is measured at a rate of 50 mm (2 in.) per minute at room temperature.
5. The test is conducted 15 minutes after the lap is formed as per manufacturer's instructions and run at a rate of 50 mm (2 in.) per minute.

2.1 ANCILLARY PRODUCTS

- A. Waterstop: ADCOR® hydrophilic waterstop or DE NEEF® Injecto® Tube groutable waterstop by GCP Applied Technologies for non-moving concrete construction joints.
- B. Preformed Soil Retention Wall Tieback Cover: PREPRUFE® Tieback Cover by GCP Applied Technologies as a prefabricated detail for soil retention wall tiebacks.
- C. Tape for covering cut edges, roll ends, penetrations and detailing: PREPRUFE® Tape LT (for temperatures between 25°F (-4°C) and 86°F (30°C)) and PREPRUFE® Tape HC (for use in Hot Climates, minimum 50°F (10°C))
- D. Miscellaneous Materials: accessories specified or acceptable to manufacturer of pre-applied waterproofing membrane.

PART 3- EXECUTION**3.0 EXAMINATION**

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the Contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.1 SUBSTRATE PREPARATION

- A. It is essential to create a sound and solid substrate to eliminate movement during the concrete pour. Substrates must be regular and smooth with no gaps or voids greater than 0.5 in. (12 mm). Grout around all penetrations such as utility conduits, etc. for stability.
 - 1. Horizontal Surfaces - The substrate must be free of loose aggregate and sharp protrusions. Avoid curved or rounded substrates. When installing over earth or crushed stone, ensure substrate is well compacted to avoid displacement of substrate due to traffic or concrete pour. The surface does not need to be dry, but standing water must be removed.

3.2 INSTALLATION, HORIZONTAL APPLICATIONS

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:
 - 1. Place the PREPRUFE® 300R membrane HDPE film side to the substrate with the clear plastic release liner facing towards the concrete pour. End laps should be staggered to avoid a build-up of layers.
 - 2. Leave the plastic release liner in position until overlap procedure is completed.
 - 3. Accurately position succeeding sheets to overlap the previous sheet 3 in. (75 mm) along the marked selvedge. Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap.
 - 4. Peel back the plastic release liner from between the overlaps as the two layers are bonded together. Ensure a continuous bond is achieved without creases and roll firmly with a heavy roller.
 - 5. Completely remove the plastic liner to expose the protective coating. Any initial tack will quickly disappear.

3.3 WATERSTOP INSTALLATION

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:
 - 1. Secure ADCOR® hydrophilic waterstop using masonry nails 1½ in. - 2 in. (40 mm – 50 mm) long with a washer ¾ in. (20 mm) in diameter. Hilti EM6-20-12 FP8 shot fired fixings with ¼ in. (6 mm) nuts and ¾ in. (20 mm) diameter washers may also be used. Fixings should be spaced at a maximum of 12 in. (300 mm) centers with a minimum spacing that ensures proper contact to substrate.
 - 2. On irregular concrete faces, apply a ½ in. (12 mm) bead of ADCOR® Adhesive as bedding for ADCOR® hydrophilic waterstop.
 - 3. ADCOR® hydrophilic waterstop joints should overlap a minimum of 4 in. (100 mm), ensuring full contact between jointed pieces.

3.4 PROTECTION

- A. Protect membrane in accordance with manufacturer's recommendations until placement of concrete. Inspect for damage just prior to placement of concrete and make repairs in accordance with manufacturer's recommendations.

SECTION 07133 - SELF-ADHERING SHEET WATERPROOFING**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. The work of this section includes, but is not limited to, the following:
 - 1. Rubberized asphalt sheet membrane waterproofing system
 - 2. Prefabricated drainage composite
 - 3. Protection board
- B. Related Section:
 - 1. Division 03 Section "Concrete Formwork"
 - 2. Division 03 Section "Cast-in-Place Concrete"
 - 3. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing"

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
- B. Shop Drawings: SUBMITTAL NOT REQUIRED BY ARCHITECT. PROVIDE DOCUMENTS TO VIOC Construction Manager if required. Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
- C. Samples:
 - 1. Sheet membrane
 - 2. Protection board
 - 3. Prefabricated drainage composite
- D. Qualification Data: For Installer.
- E. Product Test Reports: For waterproofing, based on evaluation of comprehensive tests performed by a qualified testing agency.
- F. Field quality-control reports.
- G. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: A firm which has at least 3 years' experience in work of the type required by this section.
- B. Materials: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
- C. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- D. Schedule Coordination: Schedule work such that membrane will not be left exposed to weather for longer than recommended by the manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.
 - 1. Do not double-stack pallets of membrane on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
 - 2. Protect surface conditioner from freezing.
- B. Sequence deliveries to avoid delays, but minimize on-site storage.
- C. Safety and Handling: Users must read and understand the product label and Safety Data Sheets (SDS's) for each system component before use. All users must acquaint themselves with this information prior to working with the material. Carefully read detailed precaution statements on the product labels and SDS's before use.

1.5 PROJECT CONDITIONS

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.
- B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

1.6 WARRANTY

- A. Sheet Membrane Waterproofing: Provide written 5 year material warranty issued by the membrane manufacturer upon completion of the work.

PART 2- PRODUCTS

2.0 WATERPROOFING SYSTEM PRODUCTS

- A. Sheet Membrane Waterproofing System: BITUTHENE® System 4000 Membrane as manufactured by GCP Applied Technologies; a self-adhesive, cold-applied composite sheet consisting of a thickness of 1.4 mm (0.056 in.) of rubberized asphalt and 0.1 mm (0.004 in.) of cross-laminated, high density polyethylene film specially formulated for use with water-based surface conditioner. Provide rubberized asphalt membrane covered with a release sheet, which is removed during installation and no special adhesive or heat shall be required to form laps. Provide membrane with the following physical properties:

PHYSICAL PROPERTIES FOR BITUTHENE® SYSTEM 4000 MEMBRANE:

Property	Test Method	Typical Value
Color		Dark gray-black
Thickness	ASTM D 3767 Method A	60 mils (1.5 mm) nominal
Flexibility, 180° bend over 25 mm (1 in.) mandrel at -32°C (-25°F)	ASTM D 1970	Unaffected
Tensile Strength, Membrane Die C	ASTM D 412 ¹	2240 kPa (325 psi) minimum
Tensile Strength, Film	ASTM D 882 ¹	34.5 MPa (5,000 psi) minimum
Elongation, Ultimate Failure of Rubberized Asphalt	ASTM D 412 ¹	300% minimum
Crack Cycling at -32°C (-25°F), 100 Cycles	ASTM C 836	Unaffected
Lap Shear	ASTM D 1002 ²	89 N (20 lbs.) minimum

Property	Test Method	Typical Value
Peel Strength	ASTM D 903	1926 N/m (11 lbs/in.) minimum
Puncture Resistance, Membrane	ASTM E 154	222 N (50 lbs.) minimum
Resistance to Hydrostatic Head	ASTM D 5385	>70 m (>230 ft) of water
Permeance	ASTM E 96, Section 12 – Water Method	<0.1 perms
Water Absorption	ASTM D 570	0.1% (maximum)

Footnotes:

1. The test is run at a rate of 50 mm (2 in.) per minute.
2. The test is run at a rate of 100 mm (4 in.) per minute

2.1 ANCILLARY PRODUCTS – (reference gcpat.com for complete technical details)

- A. Prefabricated Drainage Composite: HYDRODUCT® 220 and/or HYDRODUCT® 660 Drainage Composite as manufactured by GCP Applied Technologies to promote positive drainage while serving as a protection course.
NOTE TO SPECIFIER: The following are product selection guidelines for HYDRODUCT® Drainage Composites. Consult the “Product Summary” and “System Components” section of the Waterproofing Systems Manual North American Edition for complete information. HYDRODUCT® 220 drainage composite: All vertical applications. HYDRODUCT® 660: All horizontal applications. THE APPROPRIATE HYDRODUCT® DRAINAGE COMPOSITE MAY ALSO SERVE AS PROTECTION FOR ALL BITUTHENE® MEMBRANES.
- B. Protection Board:
 1. Expanded Polystyrene Protection Board: 25 mm (1 in.) thick for vertical applications with the following characteristics. Adhere to waterproofing membrane with BITUTHENE® Protection Board Adhesive.
 - a. Normal Density: 16 kg/m³ (1.0 lb/ft³)
 - b. Thermal Conductivity, K factor: 0.24 at 5°C (40°F), 0.26 at 24°C (75°F)
 - c. Thermal Resistance, R-Value: 4 per 25 mm (1 in.) of thickness.
 2. Asphalt Hardboard: A pre-molded semi-rigid protection board consisting of bitumen, mineral core and reinforcement. Provide 3 mm (0.125 in.) thick hardboard on horizontal surfaces not receiving steel reinforced slab. Where steel reinforcing bars are to be used, apply two layers of 3 mm (0.125 in.) thick hardboard or one layer of 6 mm (0.25 in.) thick hardboard.
- C. Waterstop: Adcor™ hydrophilic waterstop as manufactured by GCP Applied Technologies for non-moving concrete construction joints.
- D. Miscellaneous Materials: Surface conditioner, mastic, liquid membrane, tape and accessories specified or acceptable to manufacturer of sheet membrane waterproofing.

PART 3- EXECUTION**3.0 EXAMINATION**

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the Contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.1 SUBSTRATE PREPARATION

- A. Refer to manufacturer’s literature for requirements for preparation of substrates. Surfaces shall be structurally sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed

surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods which are acceptable to manufacturer of sheet membrane waterproofing.

- B. Cast-In-Place Concrete Substrates:
 - 1. Do not proceed with installation until concrete has properly cured and dried (minimum 7 days for normal structural concrete and minimum 14 days for lightweight structural concrete).
 - 2. Fill form tie rod holes with concrete and finish flush with surrounding surface.
 - 3. Repair bugholes over 13 mm (0.5 in.) in length and 6 mm (0.25 in.) deep and finish flush with surrounding surface.
 - 4. Remove scaling to sound, unaffected concrete and repair exposed area.
 - 5. Grind irregular construction joints to suitable flush surface.
- C. Masonry Substrates: Apply waterproofing over concrete block and brick with smooth trowel-cut mortar joints or parge coat.
- D. Wood Substrates: Apply waterproofing membrane over securely fastened sound surface. All joints and fasteners shall be flush to create a smooth surface.
- E. Related Materials: Treat joints and install flashing as recommended by waterproofing manufacturer.

3.2 INSTALLATION

- A. Refer to manufacturer's literature for recommendations on installation, including but not limited to, the following:
 - 1. Apply surface conditioner at rate recommended by manufacturer. Recoat areas not waterproofed if contaminated by dust. Mask and protect adjoining exposed finish surfaces to protect those surfaces from excessive application of surface conditioner.
 - 2. Delay application of membrane until surface conditioner is completely dry. Dry time will vary with weather conditions.
 - 3. Seal daily terminations with troweled bead of mastic.
 - 4. Apply protection board and related materials in accordance with manufacturer's recommendations.

3.3 CLEANING AND PROTECTION

- A. Protect completed membrane waterproofing from subsequent construction activities as recommended by manufacturer.
- B. Inspect for damage just prior to installation of subsequent construction activities and make repairs in accordance with manufacturer's recommendation.

SECTION 07150 - DAMPPROOFING**PART 1- GENERAL****1.0 SUMMARY**

- A. Includes the furnishing of all materials, labor, tools and equipment required for damp-proofing the underslab areas as herein specified and indicated on the drawings.

1.1 RELATED DOCUMENTS

- A. Section 31100 Site Grading, Excavation and Backfilling
- B. Section 03300 Concrete
- C. Section 04200 Unit Masonry

1.2 REFERENCE STANDARDS

- A. All materials to meet ASTM specifications or Federal specifications.

1.3 WARRANTY

- A. Guarantee material and installation for a minimum period of two years.

1.4 PRODUCT DATA

- A. Submit manufacturer's instructions and product data for all material to be used.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply damp proofing during inclement weather or when temperature is below 40 degrees.
- B. Do not apply damp proofing to damp, frozen, dirty or dusty surfaces.

PART 2- PRODUCTS**2.0 MATERIALS**

- A. Membrane Dampproofing - Rubber and Plastic Compounds Co. – Nervastral Seal-Pruf HD, 20 mil.
- B. Substitutions - Items of same function and performance are acceptable in accordance with Section 01600.

PART 3- EXECUTION**3.0 PREPARATION**

- A. All surfaces which are to receive damp proofing shall be inspected and prepared to insure the proper application of damp proofing materials.

3.1 INSTALLATION

- A. Type "A" - First Floor Slab On Grade
 - 1. Underneath the first floor interior slab on grade, install one layer of 6 mils polyethylene plastic over the gravel or sand fill. Lap all joints at least 6".

2. Prevent puncturing or otherwise damaging of this vapor barrier before and during concrete pouring. Turn up 6" at walls and penetrations. Patch all damaged surfaces.

SECTION 07190 - MASONRY WATER REPELLENTS**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes penetrating water-repellent coatings for the following surfaces:
 - 1. Concrete unit masonry (unpainted and unglazed).
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry" for integral water-repellent admixture for unit masonry assemblies.
 - 2. Division 07 Section "Joint Sealants."

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include manufacturer's printed statement of VOC content.
 - 2. Include manufacturer's standard colors.
- B. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.
- C. Manufacturer Certificates: Signed by manufacturers certifying that water repellents comply with requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Preconstruction Testing Reports: For water-repellent-treated substrates.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for assemblies.
- G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Testing Agency Qualifications: If requested by Owner, an independent agency qualified according to ASTM E 548 for testing indicated.
- C. Test Application: Apply a finish sample for each type of water repellent and substrate required. Duplicate finish of approved sample.
 - 1. Locate each test application as directed by Owner.
 - 2. Size: 25 sq. ft., minimum.
 - 3. Apply in accordance with manufacturer's written instructions.
 - 4. Allow protective treatment test area to cure prior to inspection.
 - 5. Final approval by Architect of water-repellent application will be from test applications.

1.4 PROJECT CONDITIONS

- A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
 - 1. Ambient temperature is above 40 deg F.
 - 2. Masonry surfaces and mortar have cured for more than 28 days.

3. Masonry walls are not treated prior to 30 days after building close-in.
4. Rain or snow is not predicted within 24 hours.
5. Application proceeds more than 24 hours after surfaces have been wet.
6. Substrate is not frozen, or surface temperature is above 40 deg F.
7. Windy conditions do not exist that may cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agrees to repair or replace materials that fail to maintain water repellency within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2- PRODUCTS

2.0 PENETRATING WATER REPELLENTS

- A. Water Based Silicone Emulsion Water Repellant: Clear-drying, water-based silicone emulsion for weatherproofing concrete block and other porous masonry materials, protects masonry surfaces from graffiti attacks without altering the natural appearance; protects exterior walls exposed to normal weathering.

2.1 MANUFACTURERS

- A. Products:
 - a. ProSoCo, Inc.; Sure Klean Weather Seal Block-Guard and Blok-Guard and Graffiti Control II.

PART 3- EXECUTION

3.0 PREPARATION

- A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to water-repellent manufacturer's written instructions, to ensure that surface is dry enough.
- B. Test for pH level, according to water-repellent manufacturer's written instructions, to ensure chemical bond to silicate minerals.
- C. Protect adjoining work, including sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live plants and grass.
- D. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 APPLICATION

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.

- B. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated.
- C. Apply a second saturation spray coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.2 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Repair damage caused by water-repellent application. Comply with manufacturer's written cleaning instructions.

SECTION 07210 - BUILDING THERMAL INSULATION**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Perimeter insulation under slabs-on-grade.
 - 2. Perimeter wall insulation (supporting backfill).
 - 3. Concealed building insulation.
 - 4. Vapor retarders.
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry" for insulation installed in masonry cells.
 - 2. Division 07 Section "Water-Drainage Exterior Insulation and Finish System (EIFS)" for insulation specified as part of these systems.
 - 3. Division 07 Section "Thermoplastic Membrane Roofing" for insulation specified as part of roofing construction.
 - 4. Division 09 Section "Gypsum Board" for installation in metal-framed assemblies of insulation specified by referencing this Section.
 - 5. Division 22 Section "Plumbing Insulation."
 - 6. Division 23 Section "HVAC Insulation."

1.2 DEFINITIONS

- A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Test Reports: If Requested by Owner; based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E 84.
 - 2. Fire-Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect plastic insulation as follows:
 - 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:
 - 1. Manufacturers:
 - a. DiversiFoam Products.
 - b. Dow Chemical Company.
 - c. Owens Corning.
 - d. Pactiv Building Products Division.
 - 2. Type IV, 1.60 lb/cu. ft., unless otherwise indicated.

2.2 GLASS-FIBER BLANKET INSULATION

- A. Manufacturers:
 - 1. CertainTeed Corporation.
 - 2. Guardian Fiberglass, Inc.
 - 3. Johns Manville.
 - 4. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics, and formaldehyde free.
- C. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim-kraft, foil-scrim, or foil-scrim-polyethylene vapor-retarder membrane on 1 face, and formaldehyde free.

2.3 VAPOR RETARDERS

- A. Fire-Retardant, Reinforced-Polyethylene Vapor Retarders: 2-outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nonwoven grid of nylon cord or polyester scrim and weighing not less than 10.5 kg.100 sq. m (22 lb/1000 sq. ft.), with maximum permeance rating of 7.5 ng/Pa x s x sq. m (0.1317 perm) and with flame-spread and smoke-developed indexes of not more than 5 and 60, respectively.

1. Products:
 - a. Raven Industries Inc.; DURA-SKRIM 2FR.
 - b. Reef Industries, Inc.; Griffolyn T-55 FR.
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.
- D. Single-Component Non-Sag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, use NT related to exposure, and Use O related to vapor-barrier-related substrates.

2.4 AUXILIARY INSULATING MATERIALS

- A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.5 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
 1. Products:
 - a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
 - b. Eckel Industries of Canada; Stic-Klip Type N Fasteners.
 - c. Gemco; Spindle Type.
 2. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
 1. Products:
 - a. AGM Industries, Inc.; TACTOO Adhesive.
 - b. Eckel Industries of Canada; Stic-Klip Type S Adhesive.
 - c. Gemco; Tuff Bond Hanger Adhesive.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

- A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.
 - 1. If not otherwise indicated, extend insulation from underside of slab on grade to top of concrete footing.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
- C. Insulation to be placed in accordance per the required min. R-values as determined in the current International Energy Conservation Code.

3.4 INSTALLATION OF GENERAL BUILDING INSULATION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side of construction, unless otherwise indicated.
 - 1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.
 - 2. Unfaced units to be used as per ASHRAE recommendations for the corresponding hygro-thermal region.
- D. Install mineral-fiber insulation in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 - 4. For wood-framed construction, install mineral-fiber blankets according to ASTM C 1320 and as follows:
 - a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

- E. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 - 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 - 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
- F. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

3.5 INSTALLATION OF VAPOR RETARDERS

- A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
- C. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.
- E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.
- F. Vapor retarder (type) to be placed in wall assembly in accordance with ASHRAE requirements for the appropriate hygro-thermal region.

3.6 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

SECTION 07241 - EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 0 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section includes water-drainage exterior insulation and finish system (EIFS) applied over weather-resistant sheathing paper over sheathing.
- B. Related Sections:
 - 1. Division 06 Section "Sheathing" for sheathing and weather-resistant sheathing paper.

1.2 SYSTEM DESCRIPTION

- A. Class PB EIFS: A non-load-bearing, exterior wall cladding system that consists of an insulation board attached adhesively, mechanically, or both to the substrate; an integrally reinforced base coat; and a textured protective finish coat.
- B. Water-Drainage EIFS: EIFS with a means that allows water entering into an EIFS assembly to drain to the exterior.

1.3 PERFORMANCE REQUIREMENTS

- A. EIFS Performance: Comply with the following:
 - 1. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
 - 2. Weathertightness: Resistant to water penetration from exterior into water-drainage EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish, and including a means that allows water entering into an EIFS assembly to drain to the exterior.
- B. Class PB EIFS: Provide EIFS having physical properties and structural performance that comply with the following:
 - 1. Abrasion Resistance: Sample consisting of 1-inch thick EIFS mounted on 1/2-inch thick gypsum board; cured for a minimum of 28 days; and showing no cracking, checking, or loss of film integrity after exposure to 528 quarts of sand when tested per ASTM D 968, Method A.
 - 2. Absorption-Freeze Resistance: No visible deleterious effects and negligible weight loss after 60 cycles per EIMA 101.01.
 - 3. Accelerated Weathering: Five samples per ICC-ES AC235 showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, delamination, or other characteristics that might affect performance as a wall cladding after testing for 2000 hours when viewed under 5 times magnification per ASTM G 153 or ASTM G 155.
 - 4. Freeze-Thaw: No surface changes, cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination, or indications of delamination between components when viewed under 5 times magnification after 10 cycles per ICC-ES AC235.

5. Mildew Resistance of Finish Coat: Sample applied to 2-by-2-inch clean glass substrate, cured for 28 days, and showing no growth when tested per ASTM D 3273 and evaluated according to ASTM D 3274.
6. Salt-Spray Resistance: No deleterious affects when tested according to ICC-ES AC235.
7. Tensile Adhesion: No failure in the EIFS, adhesive, base coat, or finish coat when tested per ICC-ES AC235.
8. Water Penetration: Sample consisting of 1-inch thick EIFS mounted on 1/2-inch thick gypsum board, cured for 28 days, and showing no water penetration into the plane of the base coat to expanded polystyrene board interface of the test specimen after 15 minutes at 6.24 lbf/sq. ft. of air pressure difference or 20 percent of positive design wind pressure, whichever is greater, across the specimen during a test period when tested per EIMA 101.02.
9. Water Resistance: Three samples, each consisting of 1-inch thick EIFS mounted on 1/2-inch thick gypsum board; cured for 28 days; and showing no cracking, checking, crazing, erosion, rusting, blistering, peeling, or delamination after testing for 14 days per ASTM D 2247.
10. Impact Resistance: Sample consisting of 1-inch thick EIFS when constructed, conditioned, and tested per EIMA 101.86; and meeting or exceeding the following:
 - a. High Impact Resistance: 90 to 150 inch-lbs.
11. Drainage: According to ICC-ES AC235.
12. Structural Performance Testing: EIFS assembly and components shall comply with ICC-ES AC235 when tested per ASTM E 330.

1.4 SUBMITTALS

- A. Product Data: For each type and component of EIFS indicated.
- B. Shop Drawings: For EIFS. Include plans, elevations, sections, details of components, details of penetration and termination, flashing details, joint locations and configurations, fastening and anchorage details including mechanical fasteners, and connections and attachments to other work.
- C. Samples: 24-inch square panels for each type of finish-coat color and texture indicated, prepared using same tools and techniques intended for actual work including custom trim, each profile, an aesthetic reveal, a typical control joint filled with sealant of color selected.
 1. Include sealants and exposed accessory Samples to verify color selected.
- D. Qualification Data: For Installer and testing agency.
- E. Manufacturer Certificates: Signed by manufacturers certifying that EIFS and joint sealants comply with requirements.
- F. Material or Product Certificates: For cementitious materials and aggregates and for each insulation and joint sealant, from manufacturer.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each water-/weather-resistive barrier, insulation, reinforcing mesh, joint sealant, and coating.
- H. Compatibility and Adhesion Test Reports: For joint sealants from sealant manufacturer indicating the following:
 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- I. Field quality-control reports and special inspection reports.
- J. Maintenance Data: For EIFS to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An installer who is certified in writing by EIFS manufacturer as qualified to install manufacturer's system using trained workers.
- B. Source Limitations: Obtain EIFS from single source from single EIFS manufacturer and from sources approved by EIFS manufacturer as compatible with system components.
- C. Fire-Test-Response Characteristics: Provide EIFS and system components with the following fire-test-response characteristics as determined by testing identical EIFS and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.
 - 1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
 - 2. Radiant Heat Exposure: No ignition of EIFS when tested according to NFPA 268.
 - 3. Potential Heat: Acceptable level when tested according to NFPA 259.
 - 4. Surface-Burning Characteristics: Provide insulation board, adhesives, base coats, and finish coats with flame-spread index of 25 or less and smoke-developed index of 450 or less, per ASTM E 84.
- D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution and set quality standards for fabrication and installation.
 - 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original, unopened packages with manufacturers' labels intact and clearly identifying products.
- B. Store materials inside and under cover; keep them dry and protected from weather, direct sunlight, surface contamination, aging, corrosion, damaging temperatures, construction traffic, and other causes.
 - 1. Stack insulation board flat and off the ground.
 - 2. Protect plastic insulation against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - 3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Maintain ambient temperatures above 40 deg F for a minimum of 24 hours before, during, and after adhesives or coatings are applied. Do not apply EIFS adhesives or coatings during rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.

1.8 COORDINATION

- A. Coordinate installation of EIFS with related Work specified in other Sections to ensure that wall assemblies, including sheathing, weather-resistant sheathing paper, flashing, trim, joint sealants, windows, and doors, are protected against damage from the effects of weather, age, corrosion, moisture, and other causes. Do not allow water to penetrate behind flashing and drainage plane that is behind water-drainage EIFS.

PART 2- PRODUCTS**2.0 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Dryvit Systems, Inc.
 2. Finestone; Degussa Wall Systems, Inc.
 3. Senergy; Degussa Wall Systems, Inc.
 4. SonoWall; Degussa Wall Systems, Inc.
 5. Sto Corp.
 6. TEC; an H. B. Fuller company.

2.21 MATERIALS

- A. Compatibility: Provide water-resistive coating, adhesive, fasteners, board insulation, reinforcing meshes, base- and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates and approved for use by EIFS manufacturer for Project.
- B. Water-Resistive Coatings: EIFS manufacturer's standard formulation and accessories for use as water/weather-resistive barriers, compatible with substrate, and complying with physical and performance criteria of ICC-ES AC212.
1. Sheathing Joint Tape: Type recommended by EIFS manufacturer for sealing joints between and penetrations through sheathing.
 2. VOC Content of Coatings Used as Insulation Adhesive: 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Primer/Sealer: EIFS manufacturer's standard substrate conditioner with VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), designed to seal substrates from moisture penetration and to improve the bond between substrate of type indicated and adhesive used for application of insulation.
- D. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
- E. Drainage Mat: Three-dimensional, non-woven, entangled filament, nylon or plastic mat designed to drain incidental moisture by gravity; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer with manufacturer's standard corrosion-resistant mechanical fasteners suitable for intended substrate.
- F. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; with VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Molded, Rigid Cellular Polystyrene Board Insulation: Comply with ASTM C 578, Type I; EIFS manufacturer's requirements; and EIMA's "EIMA Guideline Specification for Expanded Polystyrene (EPS) Insulation Board" for most stringent requirements for material performance and qualities of insulation, including dimensions and permissible variations, and the following:
1. Aging: Before cutting and shipping, age insulation in block form by air drying for not less than six weeks or by another method approved by EIMA that produces equivalent results.
 2. Flame-Spread and Smoke-Developed Indexes: 25 and 450 or less, respectively, per ASTM E 84.
 3. Dimensions: Provide insulation boards not more than 24 by 48 inches and in the thickness indicated, but not more than 4 inches thick or less than thickness allowed by ASTM C 1397.
 4. Channeled Board Insulation: EIFS manufacturer's standard factory-fabricated profile with linear, vertical drainage channels, slots, or waves on the back side of board.

- H. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multi-end strands with retained mesh tensile strength of not less than 120 lbf/in. per EIMA 105.01; complying with ASTM D 578 and the following:
 - 1. High-Impact Reinforcing Mesh: Not less than 15 oz/sq. yd.
 - 2. Strip Reinforcing Mesh: Not less than 3.75 oz/sq. yd.
 - 3. Detail Reinforcing Mesh: Not less than 4.0 oz/sq. yd.
 - 4. Corner Reinforcing Mesh: Not less than 7.2 oz/sq. yd.
- I. Base-Coat Materials: EIFS manufacturer's standard mixture complying with one of the following requirements:
 - 1. Job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement.
 - 2. Job-combined formulation of manufacturer's standard polymer-emulsion adhesive and manufacturer's standard dry mix containing portland cement.
 - 3. Factory-blended dry formulation of portland cement, dry polymer admixture, and inert fillers to which only water is added at Project site.
 - 4. Factory-mixed non-cementitious formulation of polymer-emulsion adhesive and inert fillers that is ready to use without adding other materials.
- J. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
- K. Finish-Coat Materials: EIFS manufacturer's standard: Refer to exterior finish schedule on drawings.
- L. Water: Potable.
- M. Mechanical Fasteners: EIFS manufacturer's standard corrosion-resistant fasteners consisting of thermal cap, standard washer and shaft attachments, and fastener indicated below; selected for properties of pullout, tensile, and shear strength required to resist design loads of application indicated; capable of pulling fastener head below surface of insulation board; and of the following description:
 - 1. For attachment to steel studs from 0.033 to 0.112 inch in thickness, provide steel drill screws complying with ASTM C 954.
 - 2. For attachment to light-gage steel framing members not less than 0.0179 inch in thickness, provide steel drill screws complying with ASTM C 1002.
 - 3. For attachment to wood framing members and plywood sheathing, provide steel drill screws complying with ASTM C 1002, Type W.
 - 4. For attachment, provide manufacturer's standard fasteners suitable for substrate.
- N. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
 - 1. Casing Bead: Prefabricated, one-piece type for attachment behind insulation, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 - 2. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 - 3. Weep Screed/Track: Prefabricated, one-piece type for attachment behind insulation with perforated face leg extended to form a drip and weep holes in track bottom, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg; designed to drain incidental moisture that gets into wall construction to the exterior at terminations of EIFS with drainage.
 - 4. Expansion Joint: Prefabricated, one-piece V profile; designed to relieve stress of movement.
 - 5. Window Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.

2.2 ELASTOMERIC SEALANTS

- A. Elastomeric Sealant Products: Provide EIFS manufacturer's listed and recommended chemically curing, elastomeric sealant that is compatible with joint fillers, joint substrates, and other related materials, and complies with requirements for products and testing indicated in ASTM C 1481 and with requirements in Division 07 Section "Joint Sealants" for products corresponding to description indicated below:
 - 1. Multi-component, non-sag urethane sealant.
 - 2. Provide sealants, for use inside the weatherproofing system, with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Preformed Foam Sealant Products: Provide sealant compatible with adjacent materials and complying with requirements in Division 07 Section "Joint Sealants."
- C. Sealant Color: As selected by Owner from manufacturer's full range.

2.3 MIXING

- A. General: Comply with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of EIFS.
- B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after surfaces are dry.
 - 2. Application of coating indicates acceptance of surfaces and conditions.

3.1 PREPARATION

- A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
- B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.
- C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.2 EIFS INSTALLATION, GENERAL

- A. Comply with EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.

3.3 SUBSTRATE PROTECTION APPLICATION

- A. Primer/Sealer: Apply over plywood substrates to protect substrates from degradation and where required by EIFS manufacturer for improving adhesion of insulation to substrate.
- B. Water-Resistive Coatings: Apply over substrates to protect substrates from degradation and to provide water-/weather-resistive barrier.
 - 1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.
- C. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

3.4 TRIM INSTALLATION

- A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, at window sills, and elsewhere as indicated, according to EIFS manufacturer's written instructions. Coordinate with installation of insulation.
 - 1. Weep Screed/Track: Use at bottom termination edges, at window and door heads of water-drainage EIFS unless otherwise indicated.
 - 2. Window Sill Flashing: Use at windows unless otherwise indicated.
 - 3. Expansion Joint: Use where indicated on Drawings.
 - 4. Casing Bead: Use at other locations.

3.5 DRAINAGE MAT INSTALLATION

- A. Drainage Mat: Apply wrinkle free, continuously, with edges overlapped mechanically secured with fasteners over water-/weather-resistive barrier according to manufacturer's written instructions.

3.6 INSULATION INSTALLATION

- A. Board Insulation: Adhesively and mechanically attach insulation to substrate in compliance with ASTM C 1397, EIFS manufacturer's written instructions, and the following:
 - 1. Press and slide insulation into place. Apply pressure over the entire surface of insulation to accomplish uniform contact, high initial grab, and overall level surface.
 - 2. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 24 hours, before installing mechanical fasteners, beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
 - 3. Mechanically attach insulation to substrate by method complying with EIFS manufacturer's written instructions. Install top surface of fastener heads flush with plane of insulation. Install fasteners into or through substrates with the following minimum penetration:
 - a. Steel Framing: 5/16 inch.
 - b. Wood Framing: 1 inch.
 - 4. Apply insulation over drainage mat and dry substrates in courses with long edges of boards oriented horizontally.
 - 5. Begin first course of insulation from screed/track and work upward. Work from perimeter casing beads toward interior of panels if possible.
 - 6. Place insulation with adhesive strips and channels, slots, or waves aligned in the vertical position for drainage. Align drainage channels, slots, or waves with channels, slots, or waves in insulation boards above and below.
 - 7. Interlock ends at internal and external corners.

8. Abut insulation tightly at joints within and between each course to produce flush, continuously even surfaces without gaps or raised edges between boards. If gaps greater than 1/16 inch occur, fill with insulation cut to fit gaps exactly; insert insulation without using adhesive or other material.
9. Cut insulation to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
10. Rasp or sand flush entire surface of insulation to remove irregularities projecting more than 1/16 inch from surface of insulation and to remove yellowed areas due to sun exposure; do not create depressions deeper than 1/16 inch.
11. Cut aesthetic reveals in outside face of insulation with high-speed router and bit configured to produce grooves, rabbets, and other features that comply with profiles and locations indicated. Do not reduce insulation thickness at aesthetic reveals to less than 3/4 inch.
12. Interrupt insulation for expansion joints where indicated.
13. Form joints for sealant application by leaving gaps between adjoining insulation edges and between insulation edges and dissimilar adjoining surfaces. Make gaps wide enough to produce joint widths indicated after encapsulating joint substrates with base coat and reinforcing mesh.
14. After installing insulation and before applying field-applied reinforcing mesh, fully wrap board edges. Cover edges of board and extend encapsulating mesh not less than 2-1/2 inches over front and back face unless otherwise indicated on Drawings.
15. Treat exposed edges of insulation as follows:
 - a. Except for edges forming substrates of sealant joints, encapsulate with base coat, reinforcing mesh, and finish coat.
 - b. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
 - c. At edges trimmed by accessories, extend base coat, reinforcing mesh, and finish coat over face leg of accessories.
16. Coordinate installation of flashing and insulation to produce wall assembly that does not allow water to penetrate behind flashing and water-/weather-resistive barrier.
- B. Expansion Joints: Install at locations indicated, where required by EIFS manufacturer, and as follows:
 1. At expansion joints in substrates behind EIFS.
 2. Where EIFS adjoin dissimilar substrates, materials, and construction, including other EIFS.
 3. Where wall height or building shape changes.
 4. Where EIFS manufacturer requires joints in long continuous elevations.

3.7 BASE-COAT INSTALLATION

- A. Base Coat: Apply to exposed surfaces of insulation in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch dry-coat thickness.
- B. Reinforcing Mesh: Embed type indicated below in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 2-1/2 inches or otherwise treated at joints to comply with ASTM C 1397 and EIFS manufacturer's written instructions. Do not lap reinforcing mesh within 8 inches of corners. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh color and pattern are not visible.
- C. Additional Reinforcing Mesh: Apply strip reinforcing mesh around openings extending 4 inches beyond perimeter. Apply additional 9-by-12-inch strip reinforcing mesh diagonally at corners of openings (re-entrant corners). Apply 8-inch wide strip reinforcing mesh at both inside and outside corners unless base layer of mesh is lapped not less than 4 inches on each side of corners.
 1. At aesthetic reveals, apply strip reinforcing mesh not less than 8 inches wide.
 2. Embed strip reinforcing mesh in base coat before applying first layer of reinforcing mesh.

- D. Double Base-Coat Application: Where indicated, apply second base coat in same manner and thickness as first application except without reinforcing mesh. Do not apply until first base coat has cured.

3.8 FINISH-COAT INSTALLATION

- A. Primer: Apply over dry base coat according to EIFS manufacturer's written instructions.
- B. Finish Coat: Apply over dry primed base coat, maintaining a wet edge at all times for uniform appearance, in thickness required by EIFS manufacturer to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
 - 1. Texture: Refer to exterior finish schedule on drawings.
- C. Sealer Coat: Apply over dry finish coat, in number of coats and thickness required by EIFS manufacturer.

3.9 INSTALLATION OF JOINT SEALANTS

- A. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section "Joint Sealants" and in ASTM C 1481.
 - 1. Apply joint sealants after base coat has cured but before applying finish coat.
 - 2. Clean surfaces to receive sealants to comply with indicated requirements and EIFS manufacturer's written instructions.
 - 3. Apply primer recommended in writing by sealant manufacturer for surfaces to be sealed.
 - 4. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint.
 - 5. Apply masking tape to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
 - 6. Recess sealant sufficiently from surface of EIFS so an additional sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

3.10 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. According to ICC-ES AC235.
- B. Testing Agency: If requested by Owner, engage a qualified testing agency to perform tests and inspections.
- C. EIFS Tests and Inspections: For the following:
 - 1. According to ICC-ES AC235.
- D. Remove and replace EIFS where test results indicate that EIFS do not comply with specified requirements.
- E. Prepare test and inspection reports.

3.11 CLEANING AND PROTECTION

- A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

SECTION 07271 - AIR/MOISTURE BARRIERS**PART 1- GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes materials and installation of vapor permeable fluid applied air and moisture barrier membrane over vertical above grade concrete walls, concrete masonry walls, and wall sheathing.
- B. Related Requirements
 - 1. Section 06 16 00: Sheathing
 - 2. Section 07 25 00: Weather Barriers
 - 3. Section 07 26 00: Vapor Retarders
 - 4. Section 07 60 00: Flashing and Sheet Metal
 - 5. Section 07 90 00: Joint Protection
 - 6. Section 08 50 00: Windows

1.3 DEFINITIONS

- A. Air Barrier Material: A primary element that provides a continuous barrier to the movement of air.
- B. Air Barrier Accessory: A transitional component of the air barrier that provides continuity.
- C. Air Barrier Auxiliary Material: A transitional component that provides air barrier continuity furnished by a source other than the primary air barrier manufacturer.
- D. Air Barrier Assembly: The collection of air barrier materials, accessory and auxiliary materials applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference
 - 1. Review air barrier installation requirements and installation details, mock-ups, testing requirements, protection, and sequencing of work.

1.5 REFERENCES

- A. Building Codes and Standards
 - 2015, 2018 IBC International Building Code
 - 2015, 2018 IRC International Residential Code

- 2015, 2018 IECC International Energy Conservation Code
- 2015 ICC-ES AC 212 ICC ES Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing
- B. AAMA – American Architectural Manufacturers Association
- AAMA 509 Voluntary Test and Classification Method of Drained and Back Ventilated Rain Screen Wall Cladding Systems
- C. AATCC – American Association of Textile Chemists and Colorists
- AATCC -TM127 Test Method for Water Resistance: Hydrostatic Pressure
- D. ASTM - American Society for Testing and Materials Standards
- C1177-13 Specification for Glass Mat Gypsum Substrate for Use as Sheathing
- C1305-08 Standard Test Method for Crack Bridging Ability of Liquid-Applied Waterproofing Membrane
- D412-06 Standardized Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
- D3273-12 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- D4541-09 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- E84-15b Standard Test Method for Surface Burning Characteristics of Building Materials
- E96-12 Test Method for Water Vapor Transmission of Materials
- E779-10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- E783-02(2010) Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- E1186-03 (2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
- E1827-11 Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- E2178-13 Test Method for Air Permeance of Building Materials
- E2357-05 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
- E. APA – The Engineered Wood Association
- E30W-2017 Engineered Wood Construction Guide
- F. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- ASHRAE 2017, Handbook-Fundamentals
- ASHRAE 90.1 2016, Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASHRAE 189.1 2014, Standard for the Design of High Performance Green Buildings Except Low-Rise Residential Buildings

G. NFPA – National Fire Protection Association

NFPA 285 2109, Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

H. South Coast Air Quality Management District (SCAQMD)
Rule 1113(2016) Architectural Coatings

1.6 COORDINATION/SCHEDULING

- A. Provide protection of rough openings before installing windows, doors, and other penetrations through the wall.
- B. Provide sill flashing to direct water to the exterior before windows and doors are installed.
- C. Install window and door head flashing immediately after windows and doors are installed.
- D. Install diverter flashings wherever water can enter the assembly to direct water to the exterior.
- E. Install parapet cap flashing and similar flashing at copings and sills to prevent water entry into the wall assembly.
- F. Install cladding within 180 days of air and moisture barrier installation.

1.7 SUBMITTALS

- A. Manufacturer's specifications, details and product data.
- B. Manufacturer's standard warranty.
- C. Samples for approval as directed by architect or owner.
- D. Shop drawings: substrate joints, cracks, flashing transitions, penetrations, corners, terminations, and tie-ins with adjoining construction, and interfaces with separate materials that form part of the air barrier assembly.

1.8 QUALITY ASSURANCE

- A. Manufacturer requirements
 - 1. Manufacturer of exterior wall air and moisture barrier materials for a minimum of 35 years in North America.
 - 2. Maintain current registered ISO 9001:2015 Certified Quality System and ISO 14001:2015 Certified Environmental Management System
- B. Contractor requirements
 - 1. Knowledgeable in the proper use and handling of Sto materials.
 - 2. Employ skilled mechanics who are experienced and knowledgeable in waterproofing and air barrier application, and familiar with the requirements of the specified work.
 - 3. Provide the proper equipment, manpower and supervision on the job-site to install the air barrier assembly in compliance with the project plans &

specifications, shop drawings, and Sto's published specifications and details.

C. Regulatory Compliance

1. Primary air barrier and joint treatment materials:
 - a. Comply with VOC requirements for Building Envelope Coatings of SCAQMD Rule 1113 - 2016.
 - b. Comply with air barrier material requirements of ASHRAE 90.1 – 2016
 - c. Comply with air barrier material requirements of ASHRAE 189.1 – 2014
 - d. Comply with 2015 and 2018 IRC requirement for a continuous air barrier
 - e. Comply with air barrier material requirements of 2015 and 2018 IBC and IECC
 - f. Comply with 2015 ICC-ES AC 212 requirements for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing

D. Mock-ups

1. Build stand-alone site mock up or sample wall area on as-built construction to incorporate back-up wall construction, typical details covering substrate joints, cracks, flashing transitions, penetrations, corners, terminations, tie-ins with adjoining construction, and interfaces with separate materials that form part of the air barrier assembly.

1.9 PRE-CONSTRUCTION TESTING

- A. Conduct site testing by qualified test agency or building envelope consultant.
1. Conduct assembly air leakage testing in accordance with ASTM E783.
 2. Conduct adhesion testing to substrates in accordance with ASTM D4541.
 3. Conduct wet sealant compatibility testing in accordance with sealant manufacturer's field quality control test procedure.
 4. Notify design professional minimum 7 days prior to testing.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver all materials in their original sealed containers bearing manufacturer's name and identification of product.
- B. Protect coatings (pail products) from freezing temperatures and temperatures in excess of 90 degrees F (32 degrees C). Store away from direct sunlight.
- C. Protect Portland cement based materials (bag products) from moisture and humidity. Store under cover off the ground in a dry location.
- D. Protect and store accessory and auxiliary products in accordance with manufacturer's written instructions.

1.11 PROJECT/SITE CONDITIONS

- A. Maintain ambient and surface temperatures between 40 degrees F (4 degrees C) and 100 degrees F (38 degrees C), during application and drying period, and for minimum 24 hours after application of air/moisture barrier materials.
- B. Provide supplementary heat for installation in temperatures less than 40 degrees F (4 degrees C) or if surface temperature is likely to fall below 40 degrees F (4 degrees C).
- C. Provide protection of surrounding areas and adjacent surfaces from application of materials.

1.12 WARRANTY

- A. Provide manufacturer's standard warranty.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Sto Corp.
- B. Obtain primary air barrier and accessory air barrier materials from single source.

2.2 MATERIALS

- A. Primary Air Barrier Material: Sto AirSeal – ready-mixed flexible spray applied vapor permeable air and moisture barrier material
- B. Accessory Materials
 - 1. *Sheathing Joint, Rough Opening, Shingle Lap at Flashing, Small Penetrations or Attachments (scupper, pipe, electrical box) and other static transitions in above grade wall construction*
 - a. Sto RapidGuard™: one component STPE rapid drying gun-applied material
 - b. Sto Gold Fill® with StoGuard Mesh: ready mixed coating applied by trowel or knife over nominal 4.2 oz/yd² (142 g/m²) self-adhesive, flexible, symmetrical, interlaced glass fiber mesh
 - c. Sto AirSeal with StoGuard Fabric: flexible air and moisture barrier material with non-woven integrally reinforced embedded cloth reinforcement
 - 2. Floor Line Deflection Joints, Masonry Control Joints, Through Wall Joints in Masonry or Frame Construction, and other dynamic joints conditions in above grade wall construction
 - a. Sto AirSeal with StoGuard Transition Membrane: flexible air and moisture barrier with embedded flexible membrane material

2.3 PERFORMANCE REQUIREMENTS

- A. Water Penetration Resistance Rating: AAMA 509, W1 in StoVentec Systems

- B. Water Column: AATCC 127 (modified), no water penetration at 5 hours
- C. Crack Bridging: ASTM C1305, no cracking after 10 cycles at -15° F (-26° C)
- D. Tensile Strength: ASTM D412, > 15 psi (103 kPa)
- E. Elongation: ASTM D412, > 500% at 40 mil DFT, > 450% at 30 mil DFT
- F. Resistance to mold growth: ASTM D3273, Rating = 10, no growth at 70 days
- G. Adhesion: joint treatment and primary air barrier material, ASTM D 4541, ≥ 15 psi (103 kPa), or exceeds strength of glass mat facing on glass mat gypsum substrates
- H. Surface burning: ASTM E84, Flame Spread < 25, Smoke Developed < 100, Class A Building Material
- I. Water vapor permeability: ASTM E96 Method B, > 12 perms (689 ng/Pa·s·m²)
- J. Air permeance: ASTM E2178, ≤ 0.004 cfm/ft² (0.02 L/s·m²) air leakage at 1.57 psf (75 Pa)
- K. Assembly air leakage: ASTM E2357, ≤ 0.04 cfm/ft² (0.2 L/s·m²) air leakage after conditioning protocol
- L. Durability, water penetration resistance: comply with ICC-ES AC 212
- M. Fire propagation: meets requirements of NFPA 285 for use on Types I-IV construction as listed in ICC ESR 1233 and Intertek Design Listing STO/CWP 30-01 and 30-02
- N. Volatile Organic Compounds: SCAQMD Rule 1113, joint treatment and primary air barrier material < 50 g/L
- O. Water-resistive barrier: ICC ES 212, joint treatment and primary air barrier material comply

2.4

DESIGN CRITERIA

- A. Structural (Wind and Axial Loads)
 - 1. Design for maximum allowable deflection normal to the plane of the wall of: L/240. Where cladding dictates stiffer deflection criteria use cladding design criteria for maximum allowable deflection.
 - 2. Design for wind load in conformance with code requirements.
- B. Moisture Control
 - 1. Prevent the accumulation of water in the wall assembly and behind the exterior wall cladding:
 - a. Minimize condensation within the assembly.
 - b. Drain water directly to the exterior where it is likely to penetrate components in the wall assembly (windows and doors, for example).
 - c. Provide corrosion resistant flashing to direct water to the exterior in accordance with code requirements, including: above window and door heads, beneath window and door sills, at roof/wall intersections,

floor lines, decks, intersections of lower walls with higher walls, and at the base of the wall.

- C. Air Barrier Continuity: provide continuous air barrier assembly of compatible air barrier components.
- D. Substrates
 - 1. Concrete Masonry Units: provide CMU surfaces in conformance with the applicable building code, and such that a void and pinhole free air barrier is achieved. Provide normal weight units with flush joints (struck flush with the surface) and allow for a minimum of one coat of the primary air barrier material applied by spray at minimum 50 wet mils (30 mil DFT), and minimum 66 wet mils (40 DFT) where 40 DFT is specified. Alternatively, for "rough" CMU wall surfaces allow for a cementitious parge coat to fill and level irregular surfaces, prior to one coat of the primary air barrier material at minimum 50 wet mils (30 mil DFT).
 - 2. Concrete: provide concrete in conformance with the applicable building code.
 - 3. Sheathing: provide gypsum sheathing in compliance with ASTM C1177, provide APA Exterior or Exposure 1 wood-based sheathing, and provide frame/sheathing assembly that meets required design wind pressures.
- E. Mechanical Ventilation: maintain pressurization and indoor humidity levels in accordance with recommendations of ASHRAE (see 2017 ASHRAE Handbook—Fundamentals).

PART 3 _____ EXECUTION

3.1 EXAMINATION

- A. Inspect concrete and concrete masonry surfaces for:
 - 1. Contamination – algae, dirt, dust, efflorescence, form oil, fungus, grease, mildew or other foreign substances.
 - 2. Surface deficiencies – weak, friable, chalkiness, laitance, bugholes, and spalls.
 - 3. Cracks – measure crack width and record location of cracks.
 - 4. Damage or deterioration.
 - 5. Moisture content and moisture damage – use a moisture meter to determine if the surface is dry enough to receive the air and moisture barrier and record any areas of moisture damage or excess moisture.
 - 6. Flush masonry mortar joints completely filled with mortar.
- B. Inspect sheathing application for compliance with applicable requirement:
 - 1. Exterior Grade and Exposure I wood based sheathing: E30W-2017, Engineered Wood Construction Guide, and the requirements of the applicable building code.
 - 2. Glass mat faced gypsum sheathing in compliance with ASTM C1177: consult manufacturer's published recommendations and ICC ES Report. Conform with project requirements for wind load resistance.

3. Cementitious sheathing – Consult manufacturer's published recommendations and ICC ES Report. Conform with project requirements for wind load resistance.
- C. Report deviations from the requirements of project specifications or other conditions that might adversely affect the air and moisture barrier installation. Do not start work until deviations are corrected.

3.2 SURFACE PREPARATION

- A. Sheathing
 1. Remove and replace damaged sheathing.
 2. Spot surface defects such as over-driven fasteners, knot holes, or other voids in sheathing with knife grade joint treatment material.
 3. Spot surface defects and over-driven fasteners with knife grade joint treatment material or air/moisture barrier coating.

3.3 INSTALLATION

- A. Air/Moisture Barrier Installation over Exterior or Exposure I Wood-Based Sheathing (Plywood and OSB), Glass Mat Faced Gypsum Sheathing in compliance with ASTM C 1177, concrete, and concrete masonry (CMU) wall construction
- B. Coordinate work with other trades to ensure air barrier continuity with connections at foundation, floor lines, flashings, lintels and shelf angles, openings and penetrations such as pipes, vents, windows and doors, masonry anchors, rafters or beams, joints in construction, projections such as decks and balconies, and roof line.
- C. Transition Detailing: detail transition areas with Sto RapidGuard or StoGuard Transition Membrane to achieve air barrier continuity. For illustrations of installation, refer to Sto Guide Details and Sto RapidGuard Installation Guide or StoGuard Transition Membrane Installation Guide (www.stocorp.com).
- D. Rough opening protection
 1. Install rough opening protection. Refer to Sto details and applicable Sto product bulletins.
- E. Sheathing joints
 1. Install joint treatment material over sheathing joints. Refer to Sto details and applicable Sto product bulletins.
- F. Air and moisture barrier coating
 1. Sheathing
 - a. Airless spray application – Apply Sto AirSeal to the prepared substrate using airless spray equipment that pumps a minimum 1 gallon (3.8 L) per minute. Suggested tip size is .029. Pressure and tip size may vary depending on equipment used. Spray uniformly at thickness of approximately 50 wet mils to achieve minimum 30 DFT. Spray at approximately 66 wet mils where 40 mil DFT is specified. If necessary, allow material to set slightly (up to 1 hour depending on weather and substrate conditions), and double back with a second

pass to achieve total thickness. Alternatively, apply in two coats, allowing the first coat to fully dry.

3.4 FIELD QUALITY CONTROL

- A. Owner's qualified testing agency or building envelope consultant shall perform inspections and tests.
- B. Inspections: air barrier materials are subject to inspection to verify compliance with requirements.
 - 1. Condition of substrates and substrate preparation.
 - 2. Installation of primary air barrier material, accessory materials, and compatible auxiliary materials over structurally sound substrates and in conformance with architectural design details, contractor's shop drawings, project mock-up, and manufacturer's written installation instructions.
 - 3. Air barrier continuity and connections without gaps and holes at foundation, floor lines, flashings, lintels and shelf angles, openings and penetrations such as pipes, vents, windows and doors, masonry anchors, rafters or beams, joints in construction, projections such as decks and balconies, and roof line.
- C. Tests: air barrier materials and assembly are subject to tests to verify compliance with performance requirements:
 - 1. Qualitative air leakage test: ASTM E1186
 - 2. Quantitative air leakage test: ASTM E779, E783, and E1827
 - 3. Adhesion test: ASTM D4541
 - 4. Qualitative adhesion and compatibility testing: wet sealant manufacturer's field quality control adhesion test
- D. Repair non-conforming substrates and air barrier material installation to conform with project requirements.
- E. Take corrective action to repair and replace, or reinstall materials, seal openings, gaps, or other sources of air leakage to conform with project performance requirements.

3.5 PROTECTION AND CLEANING

- A. Protect air barrier materials from damage during construction caused by wind, rain, freezing, continuous high humidity, or prolonged exposure to sun light.
- B. Protect air barrier materials from damage from trades, vandals, and water infiltration during construction.
- C. Repair damaged materials to meet project specification requirements.
- D. Clean spills, stains, soiling from finishes or other construction materials that will be exposed in the completed work with compatible cleaners.
- E. Remove all masking materials after work is completed.

SECTION 07310 - SHINGLE ROOFING**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Granular surfaced asphalt shingle roofing, underlayment, eave, valley, and ridge protection.

1.1 RELATED SECTIONS

- A. Section 07620 - Sheet Metal Flashing and Trim.

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description and installation instructions for system.

1.3 QUALITY ASSURANCE

- A. The installer shall be certified by the manufacturer of the roofing system, have not less than 5 years experience in the installation of roofing.
- B. The system as installed shall comply with laws, ordinances, rules and regulations of the public authorities having jurisdiction over the work.

1.4 PROJECT CONDITIONS

- A. Proceed with roofing work only when weather conditions are in compliance with manufacturer's recommended limitations and when conditions will permit the work to proceed in accordance with requirements and the manufacturer's recommendations.
- B. Do not apply roofing materials when the roof deck is wet, and when frost, ice and snow is present on the deck. Allow surfaces to thoroughly dry before commencing work after rain, snow, and other conditions causing dampness.

1.5 WARRANTY

- A. The Contractor shall warrant the roofing system for water tightness for a period of 10 years after completion. Manufacturer's warranty shall be fully paid by the roofing contractor. Warranty shall be non-prorated and cover both labor and material, including that required to repair roof leaks. Warranty shall be signed by the contractor, roofing contractor, and manufacturer.

PART 2- PRODUCTS**2.0 ASPHALT SHINGLES**

- A. Manufacturers:
 - 1. Owens-Corning Fiberglas – Refer to exterior finishes schedule on drawings.
 - 2. Or Owner approved equal.
- B. Asphalt Shingles: ASTM D3462-87 - Mineral granule surfaced roof shingle made with glass fiber mats Dimensional shingle with a 25-Year Labor and Material Limited Warranty.

- C. Fungus Resistant: Provide shingles that have been treated to resist fungus and algae growth for a period of five years.
- D. Ice Dam Protection: If required per details, sheet barrier of rubberized asphalt bonded to sheet polyethylene, 40 mil total thickness, with strippable treated release
- E. Underlayment: Type 1, 36" wide, asphalt saturated organic felt, complying with ASTM D 226 (No. 15) or ASTM D 4869.

2.1 ACCESSORIES

- A. Nails: Standard round wire shingle nails, galvanized, 11 gauge, 3/8" heads, and of sufficient length to penetrate 1/8" through roof sheathing.
- B. Plastic Cement: Asphalt type with mineral fiber components.
- C. Ridge Vents: Subject to compliance with requirements, provide continuous ridge vents manufactured by one of the following:
 - 1. Ridge Filter Shingle vent; Air Vent, Inc.
 - 2. Ridge Filter Vent; Air Vent, Inc. (for Class A)
 - 3. Ridge Vent; GAF Building Materials Corporation

PART 3- EXECUTION

3.0 INSTALLATION OF ICE DAM PROTECTION

- A. Place eave edge metal flashings tight with fascia boards. Weather lap joints and seal with plastic cement. Secure flange with nails.
- B. Apply rubberized asphalt/polyethylene sheet eave protection in accordance with manufacturer's instructions.
- C. When drawings indicate, extend ice dam protection membrane minimum 4 ft upslope beyond interior face of exterior wall.

3.1 INSTALLATION OF PROTECTIVE UNDERLAYMENT

- A. Place one ply of underlayment over area not protected by eave protection, with ends and edges weather lapped and nailed. Stagger end laps of each consecutive layer.
- B. Install perpendicular to slope of roof.
- C. Weather lap and seal watertight with plastic cement, items projecting through or mounted on roof.

3.2 INSTALLATION OF VALLEY PROTECTION

- A. Over the underlayment, install a 36" wide valley lines of 50 lbs. or heavier smooth surface adhesive type roll roofing or shingle underlayment, nailing only along the outer edges. Install all shingles from one side of the valley and across center line a minimum of 12". Do not nail closer than 6" to center line on each side of the valley.
- B. Extend shingles on one slope across valley and fasten. Trim shingles from other slope to achieve closed cut valley, concealing the valley protection. Nails and cement, keeping nails at least 6" away from center line.

3.3 INSTALLATION OF ASPHALT SHINGLES

- A. Install shingles in accordance with manufacturer's instructions and recommendations, but not less than those recommended by ARMA's "Residential Asphalt Roofing Manual" or the "NRCA Steep Roofing Manual."
- B. Provide double course of shingles at eaves.
- C. Place shingles in straight coursing pattern with required weather exposure to produce double thickness over full roof area.

- D. Cap hips and ridges with individual shingles, maintaining weather exposure. Place to avoid exposed nails.
- E. Complete installation to provide weather tight service.

3.4 CLEAN-UP

- A. Thoroughly remove all debris from roof, gutters, and Owner's grounds.

SECTION 07545 – THERMOPLASTIC POLYOLEFIN ROOFING (TPO)**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Single ply, fully-adhered TPO roofing system.
- B. Thermal barrier.
- C. Roof insulation for this system.
- D. Roof traffic pads.
- E. Splash blocks.

1.1 RELATED SECTIONS

- A. Section 06100 - Rough Carpentry: For roof related wood blocking and curbs.
- B. Section 07620 - Sheet Metal Flashing and Trim.
- C. Section 07720 – Roof Accessories

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description and installation instructions for system.
 - 2. Certification
 - a. List of at least 2 similar completed installations using the TPO roofing system specified for this project if requested by the Owner.
 - b. At completion of work, submit roofing and insulation manufacturer's certification that roofing system was installed in accordance with manufacturer's requirements.
 - 3. Test Reports: Independent testing laboratories reports stating compliance with ASTM Specifications for each type rigid polystyrene insulation.
 - a. Test reports shall be dated within 6 months of the product manufacture date.

1.3 QUALITY ASSURANCE

- A. The installer shall be certified by the manufacturer of the TPO roofing system, have not less than 5 years experience in the installation of TPO roofing.
- B. The system as installed shall comply with laws, ordinances, rules and regulations of the public authorities having jurisdiction over the work.
- C. Inspection: Upon completion of the installation, an inspection shall be made by roof membrane manufacturer's representative, to determine that the roofing system has been installed in accordance with published specifications.

1.4 PROJECT CONDITIONS

- A. Proceed with roofing work only when weather conditions are in compliance with manufacturer's recommended limitations and when conditions will permit the work to proceed in accordance with requirements and the manufacturer's recommendations.
- B. Do not apply insulation and roofing materials when the roof deck is wet, and when frost, ice and snow is present on the deck. Allow surfaces to thoroughly dry before commencing work after rain, snow, and other conditions causing dampness.

1.5 WARRANTY

- A. The Contractor shall warrant the roofing system for water tightness for a period of **15 years** following date of completion. Manufacturer's warranty shall be fully paid by the roofing contractor. Warranty shall be non-prorated and cover both labor and material, including that required to repair roof leaks. Warranty shall be signed by the contractor, roofing contractor, and manufacturer. Final payment will not be issued until warranty is provided to Owner.
 - 1. The warranty shall include, but not be limited to, repair of leakage and the repair and/or replacement of the roofing system as necessary to correct defects or damage caused by; materials, workmanship, or wind speeds less than 72 MPH.
 - a. Materials shall include the membrane, insulation, fasteners, adhesives and tapes, flashing originally provided by the manufacturer, and all accessory products.
 - b. Repair and/or replacement of the roofing system shall include the replacement of wet insulation. For the purpose of this specification, insulation will be considered wet if either of the following exists:
 - 1) Free water is visible when the insulation is compressed.
 - 2) No free water is visible when the insulation is compressed, but the insulation is damp to the touch over a large enough area, as determined by the Director's Representative, to jeopardize the integrity of the roof system and any of its components, or to significantly lower the specified R value.

PART 2- PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

- A. For fully-adhered TPO sheet roofing membrane materials:
 - 1. Carlisle Syntec Inc. – Sure-Weld TPO Roofing System
 - 2. Firestone Building Products Co. – Ultraply TPO Roofing System
 - 3. Manville Roofing Systems Division – Ultragard TPO SRT 60.

2.1 MATERIALS

- A. TPO (Thermoplastic PolyOlefin) Membrane Roofing .060" thick conforming to the following minimum physical properties unless otherwise noted.
- B. Exposed face color: White unless otherwise noted.
 - 1. Thickness over Scrim: 0.020 inches (0.508mm).
 - 2. Breaking Strength (ASTM D 751): 250 lbf/in (1.1 kN/m) minimum.
 - 3. Tear Resistance (ASTM D 751): 55 lbf/in (245 N/M) minimum
 - 4. Elongation (ASTM D 751): 25 percent
 - 5. Sheet Dimensions, Width: 10 feet (3.05m) maximum
 - 6. Sheet Dimensions, Length: 100 feet (30.5m) maximum
- B. Flashing Material: TPO, manufacturer's standard.
- C. Molded Pipe Flashing: Manufacturer's standard.
- D. Adhesives and Sealants: Manufacturer's standard adhesive, lap sealant, bonding adhesive, water-block seal, pourable sealer and night sealant.
- E. Fastening Strip: 1" x 1/8" thick aluminum bar pre-drilled or punched for fasteners at 6" o.c. and free of burrs and sharp edges.
- F. Insulation: Closed-cell polyisocyanurate core internally laminated with facers on both sides and having an R-value of at least 5.0 according to ASTM C-518. Atlas Co. AC-Form I or Celotex Hy-Therma are acceptable.

- G. Thermal Barrier: 1/2" thick fiberboard or 1/2" gypsum wallboard type WR, or other approved material in accordance with U.B.C. Standard No. 17-3 and local building official.
- H. "Saddles " or "Crickets": Tapered insulation as specified above, uniformly tapered at 1/4" per foot.
- I. Vapor Retarder: Kraft type paper or aluminum foil type sheet as recommended by the manufacturer, 12" wide continuous; for use below all field lap splices (seams) to prevent adhesive vapor transmission.
- J. Fasteners: Tru-Fast 30 cycle drill point screws or as recommended by the manufacturer, subject to approval by the Owner's Construction Manager and local building official.
- K. Roof Traffic Pads: Semi-rigid type as recommended by the roof membrane manufacturer.
- L. Splash blocks: Pre-cast concrete splash blocks splayed to provide positive drainage away from building face, size as shown on the drawings.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine the areas and conditions under which elastic sheet roofing is to be installed and notify the Owner in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 INSTALLING INSULATION AND THERMAL BARRIER

- A. Insulation and thermal barrier shall be mechanically fastened to deck using an I-60 pattern to meet manufacturer requirements. The insulation and thermal barrier shall be neatly cut to fit around roof penetrations and projections.
 - 1. Insulation shall be installed in 2 layers (where total insulation thickness exceeds 2" or if tapered system is specified with joints staggered between each layer).
 - 2. Insulation surface joints shall be 1/4" or less in width. Repair joints wider than 1/4" with insulation.
 - 3. In no event shall more insulation be placed on the surface to be roofed than can be covered with roofing membrane prior to the onset of inclement weather, and termination of the day's work. Insulation shall be protected from water at temporary termination during installation by suitable water cut-offs.
- B. Install tapered insulation "saddles" or "crickets" where shown on the drawings to provide proper roof drainage and to avoid ponding water.

3.2 INSTALLING MEMBRANE

- A. Comply with manufacturer's instructions for the installation of membrane, including seaming, self-flashing, reinforcement (if any) and adhering sheets. Cut sheets to the maximum size possible, in order to minimize seams and to accommodate contours of roof deck and proper drainage across the shingled laps of the sheets.
- B. Lap sheets and bond joints by the seaming system recommended by the manufacturer.
- C. Bond sheets uniformly where the membrane and the roof are in contact. Bond the membrane into rain drainage work as indicated. Apply matching adhesive tape where recommended to reinforce the attachment.
- D. Water cut-offs shall be made by extending the membrane beyond the insulation and setting the end of the membrane in 4" of plastic roofing cement. Temporary water cut-offs shall be removed prior to proceeding with the next work period, by cutting off that portion of the membrane that has been in contact with plastic roofing cement, and disposing of it.

3.3 INSTALLING FLASHING

- A. Install flashing at intersections of roof with sloped and vertical surfaces, roof interruptions and penetrations in accordance with manufacturer's currently published drawings, and project drawings, consistent with job conditions.
- B. Extend base flashing up vertical surfaces and onto the horizontal roof surface not less than 3", except as otherwise shown on drawings.
- C. Terminate edges of membrane with continuous aluminum bar fastened 12" o.c. with pre-drilled expansion anchors and screws. Seal edge with lap sealant and water-block seal.

3.4 INSTALLING ROOF TRAFFIC PADS

- A. In areas to receive roof traffic pads, apply sheet membrane roofing manufacturer's recommended adhesive to membrane roof, position pads and embed into adhesive applying uniform weight to entire pad.
 - 1. Space roof traffic pads 1" to 3" apart to permit unrestricted flow of roof water.
 - 2. Width of resulting roof traffic path shall be either 24", standard traffic pad width, or as shown on the drawings, whichever is greatest.

3.5 CURB INSULATION

- A. Apply 3/4" or thicker insulation to mechanical equipment unit curbs and to other curbs where insulation is not provided with the unit.

3.6 SPLASH BLOCKS

- A. Place splash blocks at grade as shown, oriented to provide positive drainage away from building face.

3.7 ADJUSTING AND CLEANING

- A. Inspect work thoroughly and make corrections immediately.

3.8 PROTECTION

- A. The installer shall advise the Contractor and other trades of recommended protection for roofing so that the work will be without damage and deterioration (except for normal weathering) at the time of acceptance.

SECTION 07610 - ARCHITECTURAL METAL ROOFING SYSTEM**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Precoated galvanized standing seam metal roofing and associated flashings.

1.1. RELATED SECTIONS

- A. Section 07620 - Sheet Metal Flashing and Trim.

1.2 SUBMITTALS

- A. Submit the following:
 - 1. Manufacturer's Literature: Materials description and installation instructions for system.
 - 2. Sample metal roof material as requested by Owner

1.3 QUALITY ASSURANCE

- A. The installer shall be certified by the manufacturer of the standing seam metal roofing system, have not less than 5 years experience in the installation of roofing.
- B. The system as installed shall comply with laws, ordinances, rules and regulations of the public authorities having jurisdiction over the work.

1.4 PROJECT CONDITIONS

- A. Proceed with roofing work only when weather conditions are in compliance with manufacturer's recommended limitations and when conditions will permit the work to proceed in accordance with requirements and the manufacturer's recommendations.
- B. Do not apply insulation and roofing materials when the roof deck is wet, and when frost ice and snow is present on the deck. Allow surfaces to thoroughly dry before commencing work after rain, snow, and other conditions causing dampness.
- C. Verify that surfaces to receive roofing are free from debris.
- D. Examine plywood decking to ensure substrate is properly fastened to framing and prepared to receive metal roofing.
- E. Ensure decking is installed flat, free from objectionable warp, wave, and buckle.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.

- b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weather-tightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail to remain weather-tight, including leaks, within specified warranty period.
 - 1. Weather-tight Warranty Period: Five years from date of Substantial Completion.
 - 2. Liability Limit: Original cost of manufactured roof assembly materials plus installation.

PART 2- PRODUCTS

2.0 SHEET MATERIALS

- A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755.
 - 1. Galvalume Steel Sheet: ASTM A 792, structural quality.
 - 2. Thickness: 24-gauge, unless otherwise noted on Drawings.
 - 3. Surface: Smooth, flat finish.
 - 4. Exposed Coil-Coated Finish:
 - a. 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat, total minimum dry film thickness of 0.9 mils and a 30 percent reflective gloss when tested in accordance with ASTM D 523. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - i. Durability: Provide coating field tested under normal range of weather conditions for a minimum of 20-years for film integrity and 10-years without chalking in excess of a chalk rating of 8 according to ASTM D 4214; and without fading in excess of 5 Hunter units.
 - b. Color: As specified in drawings.
- B. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.1 ROOF PANEL ASSEMBLIES

- A. Standing Seam Roof Panels: Manufacturers standard factory-formed, standing-seam roof panel assembly designed for concealed mechanical attachment of roof purlins or deck.
 - 1. Panels shall be 16-inches on center with a minimum seam height of 2-inches. Panels shall be vertical leg mechanically seamed panels capable of being installed in a radius application.
 - 2. Clips: Provide stainless-steel panel clips as supplied by metal roof panel manufacturer, design to meet negative-load requirements.
 - 3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch thick, stainless-steel or nylon coated aluminum sheets.

2.3 UNDERLAYMENT MATERIALS

- A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felts.

2.4 ACCESSORIES

- A. General: Provide materials and accessories required for a complete roof panel assembly and as recommended by panel manufacturer, unless otherwise indicated.
- B. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
 - 1. Use stainless-steel fasteners for exterior applications and galvanized steel fasteners for interior applications.
 - 2. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory applied coating.
 - 3. Provide metal backed neoprene washers under heads of exposed fasteners bearing on weather side of metal roof panels.
 - 4. Locate and space exposed fasteners in the true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.
- C. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018 inch thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels
- D. Closure Strips: Closed-cell, expanded, cellular, rubber or cross-linked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or pre-molded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weather-tight construction.
- E. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
- F. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.
- G. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weather-tight; and as recommended in writing by metal roof panel manufacturer.
- H. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.
- I. Expansion Joint Sealant: For hook-type expansion joints that must be free to move, provide non-setting, non-hardening, non-migrating, heavy bodied polyisobutylene sealant.
- J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- K. Primer: Rust-inhibitive primer recommended by panel manufacturer for compatibility with finish coat.
- L. Snow Guards: Prefabricated, non-corrosive units designed to be installed without penetrating metal roof panels, and complete with predrilled holes, clamps, or hooks for anchoring.
 - 1. Surface-Mounted, Metal, Stop-Type Snow Guards: Cast-aluminum stops designed for attachment to pan surface of metal roof panel using construction adhesive, silicone or polyurethane sealant, or adhesive tape.

2.5 MANUFACTURERS

- A. Slim Seam 816 panels as manufactured by Fabral
- B. AEP-Span
- C. Berridge Manufacturing Company
- D. Petersen Aluminum Corporation
- E. Englert, Inc.

- F. McElroy Metal
- G. Firestone Una-clad

PART 3- EXECUTION

3.0 FELT UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Apply at locations indicated on Drawings, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.
 - 1. Apply over entire roof surface.
- B. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.1 INSTALLATION OF ICE DAM PROTECTION

- A. Place eave edge metal flashings tight with fascia boards. Weather lap joints and seal with plastic cement. Secure flange with nails.
- B. Apply rubberized asphalt/polyethylene sheet eave protection in accordance with manufacturer's instructions.
- C. Extend eave protection membrane minimum 4 ft. upslope beyond interior face of exterior walls.

3.2 INSTALLATION

- A. Install pans and seams in accordance with panel manufacturer's instructions and recommendations. Anchor securely in place using cleats and fasteners, spaced in accordance with manufacturer's recommendations for design wind load criteria.
- B. Fully seat adjacent panel to achieve continuous engagement of standing seam joint.
- C. Lock cleats into seams and flatten in direction of drainage. At eaves and gable ends, terminate roofing by hooking over edge strip.
- D. Finish standing seams 1 inch high on flat surfaces and 1/2 inch high on curved surfaces.
- E. Bend up one side edge 1 1/2 inch and other edge 1 3/4 inch.
- F. Make first fold 1/4 inch wide single fold and second fold 1/2 inch wide, providing locked portion of standing seam, 5 plies in thickness. Fold lower ends of seams at eaves over at 45 degree angle.
- G. Terminate standing seams at ridge and hips by turning down with tapered fold.
- H. Form valleys of sheets not exceeding 10 feet in length. Lap joints in direction of drainage. Extend concealed valley sheet under roofing sheets.
- I. At valley, double fold exposed valley and roofing sheets and secure with cleats.
- J. Where sheet metal is in contact with dissimilar metals execute juncture to facilitate drainage and minimize possibility of galvanic action. At point of contact with dissimilar metal, coat metal with protective paint or tape between metal.
- K. Field apply sealant to penetrations and locations necessary for waterproof installation.
- L. Joints in all metal flashing and trim shall lap a minimum 1" without any fasteners exposed.
- M. Downspouts shall be set plumb and not more than 1" from the wall. 14 gauge welded galvanized leaders, painted with a rust resistant paint and primer shall connect gutters to downspouts. Leaders shall be set with a slope not less than 30 degrees. Leaders shall fit over the outlet tube in gutter bottom and shall fit into and be screwed to the downspout. Strainers shall be set loosely in outlet tubes. Joints between lengths of downspouts shall be made by telescoping the end of the upper lengths at least 2" into lower length downspouts, terminating in drainage lines and neatly fitting into downspout boots with the joints left open. Downspout hangers shall be 1/16 x 1"

- flat stock of the same material as downspout. Downspouts shall be 3" by 4" and material shall match the roof.
- N. Gutters shall have expansion joints at 32 feet intervals. Dripage and fascia joints shall have expansion joints at not more than 12 foot spacing.
 - O. Avoid abrasive materials (ie. Hard sole shoes, metal shavings from cuttings, etc.) that may damage the surface.

3.3 SNOW GUARD INSTALLATION

- A. Stop-Type Snow Guards: Attach snow guards to metal roof panels with adhesive, sealant, or adhesive tape, as recommended by manufacturer. Do not use fasteners that will penetrate metal roof panels.
 - 1. Provide 2 rows of snow guards, at locations indicated on Drawings, spaced 15-inches apart, beginning 15-inches up from gutter, with each snow guard centered between panel ribs.

3.4 CLEAN-UP

- A. Clean exposed surfaces of work promptly after completion of installation.
- B. Clean roofs in accordance with manufacturer's recommendations.
- C. Protect work as required to ensure roofing will be without damage at time of final completion.

SECTION 07620 - SHEET METAL FLASHING AND TRIM**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Metal flashing and counterflashing.
- B. Metal copings, gravel stops, scuppers, gutters and downspouts.
- C. Exterior Soffits
- D. Roof curbs.
- E. Metal flashing reglets, inserts, miscellaneous sheet metal items, and accessories.
- F. Related sealant work.

1.1 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Sealants for sheet metal work are specified in Section 07900.

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Shop Drawings: Typical details of formed configurations.
 - 2. Samples: 2 - 3" x 6" samples of pre-finished sheet metal manufacturer's standard colors.

1.3 QUALITY ASSURANCE

- A. Sheet metal flashing and trim shall conform with the following:
 - 1. Recommended practices contained in "Architectural Sheet Metal Manual", Sheet Metal and Air Conditioning Contractors National Association Inc., (SMACNA) latest edition.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver sheet materials to the job site packaged in manageable bundles, properly labeled or identification. Provide raised platforms and waterproof covers to protect the materials from contamination from dirt and debris.
 - 1. Pre-finished materials masked with factory applied protective film shall be stored protected from the sun's ultraviolet rays until ready for installation.

1.5 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen and shall remain watertight.
- B. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
 - 1. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sf: 60-lbf/sf perimeter uplift force, 90-lbf/sf corner uplift force, and 30-lbf/sf outward force.
 - 2. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sf: 90-lbf/sf perimeter uplift force, 120-lbf/sf corner uplift force, and 45-lbf/sf outward force.
 - 3. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sf: 208-lbf/sf perimeter uplift force, 312-lbf/sf corner uplift force, and 104-lbf/sf outward force.

- C. Thermal movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient surface temperature changes.
- D. Temperature Change (Range): 120 deg F, ambient; 180 deg. F, material surfaces.

1.5 WARRANTY

- A. Special warranty on finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace flashing and trim that shows evidence of deterioration of factory applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to the following;
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
- B. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2- PRODUCTS

2.0 MATERIALS

- A. Fascia: Berridge .019" thick smooth aluminum break metal or as specified in drawings.
- B. Exterior Soffit: Berridge Perforated 19 gauge aluminum v-groove panel, embossed or as specified in drawings
- C. Bay Door Jambs: 24 gauge galvanized steel with Kynar based painted coating. Color as selected by Owner. Finish surface shall have a strippable protective film.
- D. Gutters: Continuous rolled 6" aluminum .032" aluminum or as specified in drawings. Utilize the hidden hanger screw system with neoprene washers.
- E. Downspouts: .3"x4" x .032" thick corrugated complete with matching elbows. Furnish with metal hangers, from same material as downspouts and anchors.
- F. When metal roof is specified, architectural trim, gutters and downspouts shall match roof panels as described in drawings.
- G. Provide color matched fasteners where fasteners are exposed to view.
- H. Provide color matched touch-up paint.

2.1 FABRICATION

- A. Form metal flashing to configurations indicated on the Drawings. Follow standard recommended practices, unless otherwise shown or specified. Fascia on gable ends shall have at least one vertical break near the roof line to provide rigidity of material.
- B. Fabricate and assemble units in the shop. Limit units to 24 feet in length. Where appearance is not a factor, work may be fabricated in 8 to 12 foot lengths.
- C. Fabricate joint cover plates 6' long minimum. Prefabricate corners, minimum 48" long in each direction.
- D. Counter flashing where shown shall be 2-piece type. Receiver shall be minimum 1-1/2" deep, have a hooked end, and a locking slot, factory formed and requiring no malleting and bending to hold cap member. Cap member shall be formed to snap into receiver and provide positive spring action against base flashing.
- E. Fabricate open-face downspouts in regions with severe winters.
- F. No pop rivets shall be permitted in face of trim.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine the areas and conditions under which roofing, flashing and sheet metal work is to be installed and notify the Owner in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Coordinate the work with other work for the correct sequencing of items which make up the entire membrane system of weatherproofing and waterproofing, and rain drainage. It is required that the flashing and sheet metal work be permanently watertight, and not deteriorate in excess of manufacturer's published limitations.

3.2 INSTALLATION

- A. Erect members plumb, level and in line securely anchored and properly related to other parts of the Work.
- B. Provide for thermal expansion of exposed sheet metal work. Hold sheet metal joints apart 1/2" and place coverplates over joints embedded in sealant for entire width of coverplate. Fasten sheet metal to wood blocking with screws through neoprene washers 1" minimum penetration. Provide 1 (one) fastener located on the rear side (concealed side) of roof edge and parapet flashing, for each 10' -0" length or less, and 1 (one) fastener located on the rear side of joint cover plates.
- D. Locate joints at roof edge and other work exposed to view with respect to control joints or other architectural features as indicated on the Drawings.
- E. Conceal fasteners and expansion provisions wherever possible.
- F. For counter flashing, place reglets in raked-out mortar joints and wedge with plugs at 12" o.c. and furnish to masonry trade for installation. Snap cap member into reglet in such a manner as to produce spring action pressure against base flashing.
- G. Where required to retain flashings, provide continuous cleat of metal specified. Lock free end of cleat into folded edge of sheet metal.
- H. Install gutter at a 1/2% slope to downspouts. Fasten gutter at adequate spacing (NTE 60") with hidden gutter hangers to secure gutters.
- I. Fasten downspouts securely to wall at bottom, middle and top of downspout with preformed hidden downspout anchors. Utilize a downspout to pipe adapter to tie into drainage system. If no storm drain, utilize elbow and concrete splash block to direct water away from building.
- J. Provide pre-finished liners in open-face downspouts when applicable.

3.3 ADJUSTING AND CLEANING

- A. Remove protective plastic film immediately after installation of pre-finished flashings and miscellaneous fabrications.
- B. Field touch-up marred and abraded surfaces with paint provided.
- C. Replace sections of flashing and trim, which exhibit abrasions on the face of surfaces exposed to view from finished grade.

SECTION 07720 - ROOF ACCESSORIES**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Roof curbs.
 - 2. Equipment supports.
 - 3. Roof supports.
 - 4. Roof access hatches.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for roof sheathing, wood cants, and wood nailers.
 - 2. Division 07 low-slope roofing Sections for roofing accessories.
 - 3. Division 07 Section "Metal Roof Panels" for preformed metal roofing and snow guards.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for metal flashing and counterflashing and miscellaneous sheet metal trim and accessories.

1.2 SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed factory-applied finish required and for each type of roof accessory indicated, prepared on Samples of size to adequately show color.

1.3 QUALITY ASSURANCE

- A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leak-proof, weather-tight, secure, and non-corrosive installation.
 - 1. With Owner's approval, adjust location of roof accessories that would interrupt roof drainage routes.

PART 2- PRODUCTS**2.0 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed in other Part 2 articles.

2.1 METAL MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653, G90 coated and mill phosphatized for field painting.
- B. Aluminum Extrusions and Tubes: ASTM B 221, alloy and temper recommended by manufacturer for type of use, mill finished.
- C. Galvanized Steel Tube: ASTM A 500, round tube, hot-dip galvanized to comply with ASTM A 123.
- D. Galvanized Steel Pipe: ASTM A 53.

2.2 MISCELLANEOUS MATERIALS

- A. Cellulosic-Fiber Board Insulation: ASTM C 208, Type II, Grade 1, 1 inch thick.
- B. Glass-Fiber Board Insulation: ASTM C 726, 1 inch thick.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities. Do not let mastic come in contact with EPDM roofing material.
- E. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other non-corrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners.
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
- G. Elastomeric Sealant: ASTM C 920, polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, and heavy bodied for hooked-type expansion joints with limited movement.
- I. Roofing Cement: ASTM D 4586, non-asbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system. Do not let roofing cement come in contact with EPDM roofing material.

2.3 ROOF CURBS

- A. Roof Curbs: Provide metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints,

with stepped integral metal cant raised the thickness of roof insulation and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Material: Galvanized steel sheet, 0.052 inch thick.
 2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 3. Factory install wood nailers at tops of curbs.
 4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 5. Factory insulate curbs with 1-1/2-inch thick, glass-fiber board insulation.
 6. Curb height may be determined by adding thickness of roof insulation and minimum base flashing height recommended by roofing membrane manufacturer. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
 7. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.
- B. Prefabricated Roof Curbs:
1. CRC-3; Custom Curb, Inc.
 2. PC-2; Pate Company.
 3. RC-2A; Roof Products & Systems Corporation.
 4. TC-3; ThyCurb; Div. of Thybar Corporation.
- C. Pipe and Conduit Penetration Cover Assemblies: Size and quantities of pipes or conduits as shown on Drawings:
1. CRC-3 and PCC; Custom Curb, Inc.
 2. PC-2 and PCC; Pate Company.
 3. EC-2A and N; Roof Products & Systems Corporation.
 4. TC-3 and TP-1; ThyCurb; Div. of Thybar Corporation.
- D. Custom Mechanical Equipment Curbs: For mechanical equipment mounted on structural steel frame:
1. CRC-3 and Isolation Rail; Custom Curb, Inc.
 2. PC-2 and Iso-Base; Pate Company.
 3. RC-2A and VR; Roof Products & Systems Corporation.
 4. TC-3 and Vibra-Curb II; ThyCurb; Div. of Thybar Corporation.
- E. Vibration Isolation Curbs:
1. Custom Isolation Curb; Custom Curb, Inc.
 2. PC-2 and Iso-Base; Pate Company.
 3. RC-2A and VR; Roof Products & Systems Corporation.
 4. TC-3 and Vibra-Curb II; ThyCurb; Div. of Thybar Corporation.

2.4 EQUIPMENT SUPPORTS

- A. Equipment Supports: Provide metal equipment supports, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported. Fabricate with welded or sealed mechanical corner joints, with stepped integral metal cant raised the thickness of roof insulation and integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.
1. Manufacturers:
 - a. CES-2; Custom Curb, Inc.
 - b. ES-2; Pate Company.
 - c. ER-2A; Roof Products & Systems Corporation.
 - d. TEMS-3; ThyCurb; Div. of Thybar Corporation.
 2. Material: Galvanized steel sheet, 0.052 inch thick.
 3. Factory-install continuous wood nailers 5-1/2 inches wide at tops of equipment supports.
 4. Metal Counterflashing: Manufacturer's standard removable counterflashing, fabricated of same metal and finish as equipment support.

5. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
6. Fabricate units to minimum height of 12 inches, unless otherwise indicated.
7. Sloping Roofs: Where slope of roof deck exceeds 1:48, fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

2.5 ROOF SUPPORTS

- A. Pipe Roof Supports: Adjustable height, extruded-aluminum tube, urethane insulation filled, 2 inches in diameter, with aluminum base plates and manufacturer's recommended hardware for mounting to structure, and extruded-aluminum carrier assemblies, suitable for quantity of pipe runs and sizes, with EPDM end caps. Include manufacturer's standard hardware for mounting to structure or structural roof deck.
 1. Pipe Support Height: As indicated.
 2. Pipe Roller Assembly: Stainless-steel roller assembly sized for supported pipes with extruded aluminum.
 3. Pipe Support Flashing: Insulated sleeve flashings with integral base flange, and EPDM grommetted top seal and base seals.
 - a. Metal: Aluminum sheet, 0.064 inch thick.

2.6 ROOF ACCESS HATCHES

- A. Roof Access Hatch. Provide thermally broken aluminum roof hatch units, with 1" rigid insulation at curbs and door and standard self-lifting mechanism. Provide manufacturer's standard hardware, including hold-open device, hinges, latch and operating handles for inside operation. Construct units to support 40 lbs. per sq. ft. live load.
 1. Curb: 12" high insulated curb.
 2. Size: 36" x 30"
 3. Finish: Mill finish aluminum.
 4. Basis of Design: Provide Type S-50 by Bilco or comparable product by Babcock-Davis, Milcor or approved equal.
- B. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
 1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
 2. Height: 42 inches above finished roof deck
 3. Finish: Mill finish aluminum.
 4. Basis of Design: Model LU-4 by Bilco or comparable product by Babcock-Davis, Milcor or approved equal

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.
 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
 2. Verify dimensions of roof openings for roof accessories.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing

- roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.
- B. Install roof accessories to fit substrates and to result in watertight performance.
 - C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
 - 1. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
 - 2. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.
 - D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 - E. Roof Curb Installation: Set roof curb so top surface of roof curb is level.
 - F. Equipment Support Installation: Set equipment support so top surface of equipment support is level.
 - G. Seal joints with butyl sealant as required by manufacturer of roof accessories.

3.2 TOUCH UP

- A. Touch up factory-primed surfaces with compatible primer ready for field painting in accordance with Division 09 painting Sections.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.3 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.

SECTION 07900 - JOINT SEALANTS

PART 1- GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1. SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Control and expansion joints in unit masonry.
 - b. Joints between different materials listed above.
 - c. Perimeter joints between materials listed above and frames of doors and windows.
 - d. Control and expansion joints in overhead surfaces.
 - e. Other joints as indicated.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Tile control and expansion joints.
 - c. Joints between different materials listed above.
 - d. Other joints as indicated.
 - 3. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry walls.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - g. Other joints as indicated.
 - 4. Interior joints in the following horizontal traffic surfaces:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Division 07 Section "Water-Drainage Exterior Insulation and Finish System (EIFS)" for sealing joints in EIFS construction.
 - 2. Division 08 Section "Glazing" for glazing sealants.
 - 3. Division 09 Section "Tiling" for sealing tile joints.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.3 SUBMITTALS

- A. Product Data: If requested by Owner; for each joint-sealant product indicated.

- B. Samples: If requested by Owner; for each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Compatibility and Adhesion Test Reports: If requested by Owner; from sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Submit not fewer than four pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.5 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet. Concrete and masonry must be cured a minimum of 28 days and be clean, dry and frost free.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.6 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

- C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 - 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2- PRODUCTS

2.0 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Owner from manufacturer's full range.

2.2 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Single-Component Neutral-Curing Silicone Sealant:
 - 1. Products:
 - a. Dow Corning Corporation; 791.
 - b. Pecora Corporation; 895.
 - c. Polymeric Systems Inc.; PSI-641.
 - d. Tremco; Spectrem 3.
 - 2. Type and Grade: S (single component) and NS (non-sag).
 - 3. Class: 50.
 - 4. Use Related to Exposure: NT (non-traffic).
 - 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
 - 6. Stain-Test-Response Characteristics: Non-staining to porous substrates per ASTM C 1248.
 - 7. Color: To match adjacent surfaces as selected by Architect.
- C. Single-Component Mildew-Resistant Acid-Curing Silicone Sealant:
 - 1. Products:
 - a. Dow Corning Corporation; 786 Mildew Resistant.
 - b. GE Silicones; Sanitary SCS1700.
 - c. Tremco; Tremsil 200 White.
 - 2. Type and Grade: S (single component) and NS (non-sag).
 - 3. Class: 25.
 - 4. Use Related to Exposure: NT (non-traffic).

5. Uses Related to Joint Substrates: G, A, and, as applicable to joint substrates indicated, O.
- D. Multi-Component Non-Sag Urethane Sealant:
 1. Products:
 - a. Master Builders Solutions; Master Seal NP 2
 - b. ITW Polymers Sealants.; SM-7120PU
 - c. Sika Corporation, Inc.; Sika Flex 1A NS polyurethane sealant.
 - d. Tremco; Vulkem 227.
 2. Type and Grade: M (multi-component) and NS (non-sag).
 3. Class: 25.
 4. Uses Related to Exposure: T (traffic) and NT (non-traffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.
- E. Multi-Component Pourable Urethane Sealant:
 1. Products:
 - a. Master Builders Solutions; Master Seal SL 2
 - b. Pecora Corporation; Dynatrol II-SG.
 - c. Sika Corporation, Inc.; Sikaflex - 2c SL.
 2. Type and Grade: M (multi-component) and P (pourable).
 3. Class: 25.
 4. Uses Related to Exposure: T (traffic) and NT (non-traffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

2.3 LATEX JOINT SEALANTS

- A. Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.
 1. Products:
 - a. Master Builders, Solutions; Master Seal NP-520
 - b. Bostik Findley; Chem-Calk 600.
 - c. Pecora Corporation; AC-20+.
 - d. Tremco; Tremflex 834.

2.4 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) as approved in writing by joint-sealant manufacturer for joint application indicated], and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean non-porous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where indicated or recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-Sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 - 4. Provide flush joint configuration where indicated per Figure 5B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 5C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Apply Sika Flex 1A NS polyurethane sealant. Color: Black at base edge of pit steel and floor.. Apply on a 45 degree angle to prevent ponding.

3.3 FIELD QUALITY CONTROL

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - 1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform five tests for the first 500 feet of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter.
 - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab in Appendix X1 in ASTM C 1193, as appropriate for type of joint-sealant application indicated.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
 - 4. Inspect tested joints and report on the following:
 - a. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each

- type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
- b. Whether sealants filled joint cavities and are free of voids.
- c. Whether sealant dimensions and configurations comply with specified requirements.
- 5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- 6. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior horizontal non-traffic and traffic isolation and contraction joints in cast-in-place concrete slabs.
 - 1. Joint Sealant: Multi-component pourable urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- B. Joint-Sealant Application: Exterior vertical control and expansion joints in unit masonry.
 - 1. Joint Sealant: Multi-component non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- C. Joint-Sealant Application: Exterior vertical joints between different materials listed above.
 - 1. Joint Sealant: Multi-component non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- D. Joint-Sealant Application: Exterior perimeter joints between exterior unit masonry or exterior insulation and finish systems and frames of doors or windows.
 - 1. Joint Sealant: Multi-component non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- E. Joint-Sealant Application: Exterior control and expansion joints in ceilings and other overhead surfaces.
 - 1. Joint Sealant: Multi-component non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- F. Joint-Sealant Application: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
 - 1. Joint Sealant: Single-component neutral-curing silicone sealant.

- 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- G. Joint-Sealant Application: Interior perimeter joints of exterior openings.
 - 1. Joint Sealant: Latex sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- H. Joint-Sealant Application: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
 - 1. Joint Sealant: Multi-component non-sag urethane sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- I. Joint-Sealant Application: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
 - 1. Joint Sealant: Single-component mildew-resistant acid-curing silicone sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- J. Joint-Sealant Application: Vertical joints on exposed surfaces of interior unit masonry and walls and partitions.
 - 1. Joint Sealant: Latex sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.
- K. Joint-Sealant Application: Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - 1. Joint Sealant: Latex sealant.
 - 2. Joint-Sealant Color: As selected by Owner from manufacturer's full range.

SECTION 08110 – HOLLOW METAL DOORS AND FRAMES

PART 1- GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard hollow metal doors and frames.
- B. Related Sections:
 - 1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
 - 2. Division 08 Section "Door Hardware" for door hardware for hollow metal doors.
 - 3. Division 08 Section "Glazing" for glass lites in hollow metal doors.
 - 4. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of conduit and preparations for power, signal, and control systems.
- C. Other Action Submittals:
 - 1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2- PRODUCTS**2.0 MANUFACTURERS**

- A. Manufacturers Supplier: Subject to compliance with requirements, provide hollow metal doors and frames as scheduled on Drawings by the following:
 - 1. Ceco, Curries or Trussbilt.

2.1 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653, Commercial Steel (CS), Type B; with minimum A40 metallic coating.
- D. Frame Anchors: ASTM A 591, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008 or ASTM A 1011, hot-dip galvanized according to ASTM A 153, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153.
- F. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143.
- G. Glazing: Comply with requirements in Division 08 Section "Glazing."
- H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.2 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - 1. Design: Flush
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - a. Fire Door Core: As required to provide fire-protection ratings indicated.
 - b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 12.3 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors.
 - 3. Vertical Edges for Single-Acting Doors: Beveled edge.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 - 4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch thick, end closures or channels of same material as face sheets.
 - 5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: 16 Gauge. Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).
- C. Interior Doors: 18 Gauge. Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 1 and Physical Performance Level C (Standard Duty), Model 2 (Seamless), 1-3/4 inch width.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.3 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: 14 Gauge, fabricated from metallic-coated steel sheet.
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Fabricate frames as full profile welded, unless otherwise indicated.
 - 3. Frames for Exterior Steel Doors: 0.053-inch thick steel sheet.
- C. Interior Frames: 16 Gauge, fabricated from cold-rolled steel sheet.
 - 1. Fabricate frames with mitered or coped corners.
 - 2. Frames for Interior Steel Doors: 0.053-inch thick steel sheet.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
 - 3. Post-installed Expansion Type for In-Place Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

2.5 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

2.6 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.7 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Four anchors per jamb.
 - c. Compression Type: Not less than two anchors in each jamb.
 - d. Post installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 - 6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
- E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.

2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.
- G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 3. Provide loose stops and moldings on inside of hollow metal work.
 4. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.8 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Install door silencers in frames before grouting.
 - c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - d. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - e. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 5. In-Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 6. In-Place Gypsum Board Partitions: Secure frames in place with post-installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 7. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - c. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.
 - 1. Secure stops with countersunk flat or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.3 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

SECTION 08305 - ACCESS DOORS AND FRAMES**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes wall and ceiling access doors and frames.
 - 1. Access doors and frames are to be used where required to access concealed items for maintenance and systems operation where indicated on Drawings or as required due to system installation.
 - a. Provide fire-rated wall and ceiling access doors and frames to correlate with fire rated construction if applicable.

1.2 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other work.
- B. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of access doors and frames through one source from a single manufacturer.
- B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics per the following test method and that are listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 or UL 10B for vertical access doors and frames.
 - 2. ASTM E 119 or UL 263 for horizontal access doors and frames.
- C. Size Variations: Obtain Owner's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.4 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed plumbing, mechanical, or other concealed work, and indicate in the schedule specified in "Submittals" Article.

PART 2- PRODUCTS**2.0 MANUFACTURERS**

- A. Manufacturers:
 - 1. Nystrom Building Products
 - 2. Owner approved equal.

2.1 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36.
- B. Steel Sheet: Uncoated or electrolytic zinc-coated, ASTM A 591 with cold-rolled steel sheet substrate complying with ASTM A 1008, Commercial Steel (CS), exposed.
- C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
- D. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.2 PAINT

- A. Shop Primer for Ferrous Metal: Fast curing, lead and chromate free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
 - 1. Apply shop primer immediately after cleaning and pretreating.

2.3 ACCESS DOORS AND FRAMES

- A. Access Door and Frame, Type II: Flush, uninsulated, fire-rated access doors and trimless frames, fabricated from stainless steel sheet.
 - 1. Nystrom Model XTN18x18CS
 - a.) Includes drip cap, gasket, masonry anchors, and mortise preparation.
 - 2. Lock cylinder: Key operated cylinder lock prepared for 1-1/8" mortise cylinder.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 - 1. Provide mounting holes in frames for attachment of units to metal or wood framing.
 - 2. Provide mounting holes in frame for attachment of masonry anchors. Furnish adjustable metal masonry anchors.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder lock, furnish two keys per lock and key all locks alike.
 - 2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

PART 3- EXECUTION

3.0 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.1 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

SECTION 08360 - OVERHEAD DOORS**PART 1- GENERAL****1.0 SUMMARY**

- A. Includes the furnishing of all materials, labor, tools, and equipment required for installation of the overhead sectional bay doors, for the project as herein specified and indicated on the drawings.

1.1 RELATED WORK

- A. Section 04200 - Masonry
- B. Section 06100 - Carpentry
- C. Section 08800 - Glass and Glazing
- D. Division 26 Sections for electrical connections including conduit and wiring for door operators.

1.2 PERFORMANCE REQUIREMENTS

- A. Wind Loading: Sectional overhead doors shall withstand a minimum wind loading pressure as noted in the Structural Drawings.
- B. Deflection: Maximum deflection of door in horizontal position shall be 1/120 of door width.

1.3 SUBMITTALS

- A. Shop Drawings: Show application to project.
- B. Product Data: Catalog sheets, specifications, and installation instructions for overhead door assemblies, finishes, and operators.
 - 1. Include complete data covering motors and controls for electric operation.
- C. Quality Control Submittals:
 - 1. Certificates: Furnish door manufacturer's certifications that the spring life of counterbalance mechanism is 25,000 cycles or more.
- D. Contract Closeout Submittals:
 - 1. Operation and maintenance data.
 - 2. Replacement parts list.

1.4 WARRANTY

- A. As set out under section 01011 – General Conditions, warranty shall be for a period of 12 months from date of substantial completion of the project.

PART 2- PRODUCTS**A. ACCEPTABLE MANUFACTURER'S**

- 1. Overhead doors: Overhead Door Company Inc. ([NATIONAL ACCOUNT – See drawings for info](#))
- 2. Door Openers: Overhead Door Company Inc.
Alternate: Liftmaster

2.1 MATERIALS FOR OVERHEAD DOORS

- A. Track for doors shall be 2"
- B. Doors shall be manufactured in strict accordance with the requirements of Underwriters Laboratories listed procedures.
- C. Door sizes shall be as shown on drawings.
- D. Clear anodized aluminum unless specified otherwise in drawings.
- E. Safety glass in all sections.

- F. Provide all necessary tracks, guides, mountings, fasteners and accessories required for complete installation.
- G. MATERIALS FOR DOOR OPENERS
 - a. Overhead Door OM-RSX-SECT-Trolley
 - b. Liftmaster "MT" for 10' high doors
 - c. Liftmaster "T" for 12' high doors

2.3 ALUMINUM DOOR SECTION

- A. Door:
 - 1. Sections: Door sections shall be fabricated from extruded aluminum shapes of 6063-T6 alloy, with wall thickness not less than 0.07 inch for a door section 1-3/4 inches thick.
 - 2. Stiles and rails shall be joined together with concealed 1/4 inch minimum diameter aluminum or non-magnetic stainless steel through-bolts full height of section.
 - 3. Meeting rails shall be formed to provide a rabbeted weather seal joint. Joints shall be welded in unexposed locations.
 - 4. Finish: Cleananodized aluminum unless specified differently in drawings.
 - 5. Bottom Rail: Reinforced full-width extruded angle, retaining U-shaped ribbed vinyl astragal.

2.4 ACCESSORIES

- A. Weatherstripping:
 - 1. Sill: Compressible and replaceable; neoprene or vinyl astragal, attached to bottom of door.
 - 2. Jambs: Neoprene or vinyl seal, full height of door.
 - 3. Head: Continuous neoprene or vinyl seal, attached to top of door.
 - 4. Door Section Joints: Compressible gasket in joints of meeting edges.
 - 5. Securely attach sill, jamb and head weatherstripping with metal fasteners or approved retainers; adhesive application will not be acceptable.
- B. Vision Panels:
- C. Metal Doors: Double-strength, "B" grade, clear sheet glass, set in rubber or neoprene channel glazing strips, with either removable interior stop of same material as door section framing or integral rubber for neoprene gasket stops.
 - 2. Alternate price to install "Safety Glass".

2.5 TRACKS, SUPPORTS, AND BUMPERS

- A. Tracks and Reinforcement: Galvanized steel tracks and reinforcement. Reinforce vertical tracks with heavy duty mounting brackets 16 inches oc or continuous steel angles welded or through bolted to track. Incline vertical tracks or otherwise design to ensure weathertight closure at jambs when door unit is closed. Reinforce horizontal tracks with continuous steel angles welded to track. Track system shall allow for normal door movement caused by temperature changes.
- B. Track Supports: Galvanized steel shapes, except as otherwise indicated.
- C. Door Bumpers: Compression spring or leaf spring bumper located at the end of each horizontal track, designed to cushion and stop door at end of opening operation.

2.6 HARDWARE

- A. Hinges and Roller Brackets: Minimum 13 gage steel hinges at each end stile and at each intermediate stile. Fabricate end stile hinges for mounting of rollers. Attach hinges to stiles and rails with thru bolts and lock nuts or lock washers and nuts, except self-tapping fasteners may be used on steel doors. Doors 14'-0" and over in width shall have double end hinges.
- B. Rollers: Heavy duty rollers with steel ball bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Where double hinges are required extend roller shaft through both hinges. Roller tires shall suit size of track and be the following type:
 - 1. Steel tires,

- C. Finish: Galvanized, unless otherwise indicated.
 - 1. Fasteners: Galvanized, cadmium plated or stainless steel, and compatible with door type.

2.7 COUNTERBALANCING MECHANISM

- A. Type: Torsion spring counterbalance mechanism consisting of helical wound oil-tempered steel torsion springs having a minimum spring life of 25,000 cycles, mounted on a solid steel keyed shaft, and connected to door with aircraft quality grade galvanized steel lift cable having a minimum safety factor of 7 to 1. Required operation force shall not exceed the following:
- B. Drums and Brackets: Cast aluminum or grey iron casting cable drums, grooved to receive and hold proper diameter cable. Counterbalance mechanism shall be mounted with adjustable ball-bearing brackets at each end of shaft and one additional mid-point bracket for shafts up to 16 feet long and 2 additional brackets at 1/3 points to support shafts over 16 feet long, unless closer spacing recommended by door manufacturer.

2.8 ELECTRIC OPERATION

- A. UL listed electric operator assembly, complete with operator/motor unit, factory pre-wired motor controller, limit devices, and remote control stations. Motor shall be removable without disturbing the limit switch adjustment and without affecting the emergency release mechanism. Approved Manufacturer- Overhead Door model OM-RSX-SECT-Trolley or alternate LiftMaster model "MT" for ten foot (10') doors and model "T" for all doors greater than ten feet (10') in height.
- B. Trolley/Drawbar Operator: V-belt or gear primary drive to suit door load and job conditions, chain and sprocket secondary drive, adjustable safety clutch, solenoid operated brake, emergency release mechanism with an auxiliary steel chain hoist which can be engaged/disengaged from floor level for mechanical operation, provide an interlock device to prevent motor from operating when release mechanism is activated. Chain to remain motionless during electric operation.
 - 1. Reinforce door section for operation attachment.
- C. Jackshaft/Hoist Operator: Side-mounted or center-mounted with V-belt, chain or gearhead primary drive to suit door load and job conditions, roller chain secondary drive, adjustable safety clutch, solenoid operated brake, emergency release mechanism with an auxiliary steel chain hoist which can be engaged/disengaged from floor level for mechanical operation, provide an interlock device to prevent motor from operating when release mechanism is activated. Chain to remain motionless during electric operation.
- D. Motor: Horsepower rating as required to open and close door at a speed not less than 3/4 foot or more than 1-1/4 feet per second without overload under any condition of operation.
 - 1. Motors shall comply with NEMA standards.
 - 2. Motors shall be designed to operate on single phase, 60 Hertz, 120 volt circuit (NEMA standard motor voltage 115V).
 - 3. Mount motor separate from reduction mechanism.
 - 4. Bearings: Equip motors 1/2 HP and larger with ball bearings.
 - 5. Housing: Drip-proof.
- E. Reversing Magnetic Motor Controller:
 - 1. Manufacturer: Allen-Bradley Co.; Cutler-Hammer, Inc.; General Electric Co.; Square D Co.; Westinghouse Electric Corp.
 - 2. Enclosure: NEMA 1.
 - 3. Control Power: Control power transformer (maximum control voltage 120 volts) mounted within motor controller enclosure.
- H. Push Button Control Stations (Interior): Momentary Pressure Switch, 3 push buttons labeled OPEN, CLOSE, STOP.
 - 1. Enclosure: NEMA 1, surface mounted unless otherwise indicated.
 - 2. Manufacturer: Allen-Bradley Bulletin 800S; Cutler-Hammer, Inc. Bulletin 10250; General Electric Co. CR-2943; Westinghouse Electric Corp. Type HD.
- I. [Electrical Eye Safety Sensors – Coordinate quantities and model # information with drawings and NATIONAL ACCOUNT MANAGER.](#)

PART 3- EXECUTION**3.0 EXAMINATION**

- A. Verification of Conditions: Examine door openings for defects that will adversely affect the execution and quality of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.1 INSTALLATION

- A. Install the Work of this Section in accordance with manufacturer's printed instructions, except as shown or specified otherwise.
 - 1. Field connections and fastening shall be as recommended by the door manufacturer for the conditions, unless otherwise indicated.
- B. Secure and support tracks as required to prevent sag, sway, and detrimental vibration during opening and closing of door.
 - 2. Fasten vertical track assembly to framing with continuous steel angles 24 inches oc or with mounting brackets 16 inches oc.
 - 3. Support horizontal (ceiling) track assembly with laterally-braced hanger at end of track, secured to overhead structural members. For doors 10 feet high and over, install an additional laterally-braced hanger at the center of horizontal tracks. Also secure horizontal track reinforcement at wall.
- C. Install bracing and supports as necessary to rigidly secure door operating equipment and appurtenances.

3.2 ADJUSTING

- A. Adjust and lubricate doors and operating equipment to operate smoothly. Adjust door fit and weatherstripping to make a watertight fit for the door perimeter.

3.3 FIELD QUALITY CONTROL

- A. Test all doors for proper operation before turning units over to the Director's Representative after testing.

3.4 CLEANING

- A. Clean doors, and clean work area surfaces that have been soiled performing the Work.

SECTION 08410 – ALUMINUM FRAMED ENTRANCES AND STOREFRONTS**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Glazed aluminum doors for manual operation.
- B. Glazed aluminum storefront.
- C. Aluminum flashing.

1.1 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Sealants as specified in Section 07900.
- B. Glass and glazing materials as specified in Section 08800.

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description and installation instructions for each system.
 - 2. Shop Drawings: Indicate sections of typical members, dimensioned plans and elevations, anchors and fasteners and their spacing, and full details of accessories required.
 - a. Show glass thickness and glazing details.
 - b. Show dimensions, installation and erection details, including connections, fasteners and welds.
 - c. Provide scaled drawings as follows:
 - 1) Plans and wall elevations at 1/2" = 1' -0".
 - 2) Typical composite members at full scale.
 - 3. Samples: If requested by Owner,
 - a. Two 8" lengths of aluminum extrusion in the finish specified.

1.3 QUALITY ASSURANCE

- A. Comply with the provisions of the following codes specifications and standards except where more stringent requirements are shown on the Drawings and specified herein.
 - 1. Aluminum Association (AA).
 - 2. American Architectural Manufacturers Association (AMA)
 - 3. National Association of Architectural Metal Manufacturers (NAMM).
 - 4. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver entrances and storefront to the Project site clearly marked for proper identification.
- B. Store in accordance with manufacturer's instructions, above ground, and protected from weather, construction activities, and other causes of damage.
- C. Materials shall be handled at the Project site to prevent damage. All damaged and otherwise unsuitable material when so determined shall be immediately removed from the Project site.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Noise or vibration caused by thermal movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water leakage through fixed glazing and framing areas.
 - e. Failure of operating components.
 - 2. Warranty Period: 2 years from date of Substantial Completion.

PART 2- PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

- A. Kawneer North America; an Alcoa Company

2.1 SYSTEMS

- A. For reference purposes only, Kawneer components are specified herein.
- B. Storefront
 - 1. "Trifab" 451-T, nominal 4 1/2" x 2", mullion system.
- C. Doors: "350" medium stile.

2.2 MATERIALS

- A. Aluminum Materials:
 - 1. Alloy: 6063 T5
 - 2. Thickness: As necessary to comply with structural and wind loading requirements, but not less than the following:
 - a. Principal Extrusions: 0.125".
 - b. Principal Formed Sheet Members: 0.125".
 - c. Extruded Glazing Stops and Trim: 0.062".
 - d. Formed Glazing Stops and Trim: 0.050".
 - f. Sheet 0.050".
- B. Aluminum, non-magnetic stainless steel, or other materials warranted by manufacturer to be non-corrosive and compatible with aluminum components.
 - 1. Do not use exposed fasteners except where unavoidable for application of hardware. Match finish of adjoining metal.
 - 2. Provide Phillips flat-head machine screws for exposed fasteners.
- C. Concealed Flashing: Dead-soft stainless steel 26-gauge minimum, type selected by manufacturer for compatibility.
- D. Brackets and Reinforcements: Manufacturer's high-strength aluminum units where feasible; otherwise, non-magnetic stainless steel or hot-dip galvanized steel complying with ASTM A123
- E. Concrete/Masonry Inserts: Cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A123.
- F. Compression Weather-stripping: Manufacturer's standard replaceable stripping of either molded neoprene gaskets complying with ASTM D2000 or molded PVC gaskets complying with ASTM D2287.
- G. Sliding Weather-stripping or sweeps: Manufacturer's standard replaceable stripping of wool, polypropylene, or nylon woven pile, with nylon fabric and aluminum strip backing.

- H. Aluminum Flashings: Smooth finish aluminum 0.062" (minimum thickness), finish to match storefront system.
- I. Refer to drawings for hardware schedule information.

2.3 FABRICATION

- A. General:
 - 1. Coordination of Fabrication: Wherever possible, check the actual frame openings and door openings in the construction work by accurate field measurement before fabrication, and show recorded measurements on final Shop Drawings. However, coordinate fabrication schedule with construction progress as directed by Contractor and avoid delays of the work. Coordinate installation tolerances to ensure proper fit of door and frame units.
 - 2. Sizes and Profiles: Required sizes for door and frame units, including profile requirements, are shown on drawings and on the door and hardware schedule. Variable dimensions are indicated, together with maximum and minimum dimensions required to achieve design requirements and coordination with other work.
 - a. Doors sizes are based upon ADA standard details. The bottom rail on all aluminum doors shall be 10 inches to serve as a kickplate.
 - 3. Prefabrication: To greatest extent possible, complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site. Disassemble components only as necessary for shipment and installation.
 - 4. Sequence: Complete cutting, fitting, forming, drilling, and grinding of metal work prior to cleaning, finishing, surface treatment, and application of finishes. Remove arises from cut edges and ease edges and corners to radius of approximately 1/64".
 - 5. Welding: Comply with AWS recommendations to avoid discoloration; grind exposed welds smooth and restore mechanical finish.
 - 6. Reinforcing: Install reinforcing as necessary for performance requirement, separate dissimilar metals with bituminous paint or other separator which will prevent corrosion.
 - 7. Continuity: Maintain accurate relation of planes and angles, with hairline fit of contacting members.
 - 8. Fasteners: Conceal fasteners wherever possible.
 - 9. All vertical members shall be continuous sections with no splices through its entire length.
- B. Stile-and-Rail Type Aluminum Doors:
 - 1. Frame: Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie-rods or j-bolts, on fabricate with structurally welded joints, at manufacturer's option.
 - 2. Glazing: Fabricate doors to facilitate replacement of glass and panels, without disassembly of door stiles and rails. Provide snap-on extruded aluminum glazing stops, with exterior stops anchored for non-removal.
- C. Non-Thermal Construction: Fabricate tubular and channel frame assemblies, as shown, with either welded or mechanical joints in accordance with manufacturer's standards, reinforced as necessary to support required loads.
- D. Finishes:
 - 1. Clear anodized finish unless specified otherwise in drawings, to comply with AAMA 611, AA-M12C22A41, Class I coating .018 mm or thicker.

2.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:
 - 1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.

2. Dimensional tolerances of building frame and other adjacent construction.
 3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Noise or vibration created by wind and by thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Sealant failure.
 - g. Failure of operating units.
 4. Notice of Acceptance: Provide products, in hurricane regions only, having a current Dade County Notice of Acceptance (NOA).
 - a. Submit structural design and engineering calculations for windows, doors and anchors prepared by, signed, and sealed by a licensed professional engineer within the same state as the designated construction location
 - b. All storefront window anchorage shall be designed to comply with the local wind load requirements of the designated construction location.
- B. Structural Loads: Provide aluminum-framed storefront system designed to perform under a wind pressure of 30lbf/sq.ft. acting inward and outward on adjoining window surfaces, but not for simultaneous occurrence. Anchors used to secure to the building shall be designed and engineered to comply with wind load requirements to comply with applicable building code requirements.
- C. Deflection of Framing Members:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed $L/175$ of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components directly below them to less than 1/8 inch and clearance between members and operable units directly below them to less than 1/16 inch.
- D. Structural-Test Performance: Provide aluminum-framed systems tested according to ASTM E 330 as follows:
1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.
 2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
 3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.
- E. Windborne-Debris-Impact-Resistance Performance: Provide aluminum-framed systems that pass missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and testing information in ASTM E 1996 or AAMA 506.
1. Large-Missile Impact: For aluminum-framed systems located within 30 feet of grade.
 2. Small-Missile Impact: For aluminum-framed systems located more than 30 feet above grade.
- F. Structural Support Movement: Provide aluminum-framed systems that accommodate structural movements including, but not limited to, sway and deflection.
- G. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.
- H. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested in accordance with ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft.

- I. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- J. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 35 when tested according to AAMA 1503.
- K. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.
- L. Dimensional Tolerances: Provide aluminum-framed systems that accommodate dimensional tolerances of building frame and other adjacent construction.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine the surrounding structure and the conditions under which the work is to be erected, and notify the Contractor in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Comply with manufacturer's instructions and recommendations for installation of aluminum framing systems.
- B. Set units plumb, level, and true to line, without warp and rack of framing members doors, and panels. Care should be taken as not to force units into position that would result in inherent stresses. Anchor securely in place, separating aluminum and other corrodible metal surfaces from sources of corrosion of electrolytic action
- C. Set sill members and other members in a bed of grout as shown.
- D. Comply with manufacturer's recommendations and Section 08800 for glass and glazing work.
- E. Cooperate and coordinate with Electrical Subcontractor and Owner's Security Alarm Contractor in installing low voltage wiring and reed switches in door frame heads and master keying system for security requirements if required.
- F. Bolt through frames and doors in order to attach closures and apply surface-mounted hardware items complying with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.
- G. Install push/pull bars at a height of 3'-8" above finish floor.
- H. Vertical mullions to be terminated short of bottom side of truss so as to allow for live load deflection of roof system.

3.2 ADJUSTING AND CLEANING

- A. Adjust operating hardware to function properly, without binding, and to provide tight fit at contact points and weather-stripping.
- B. Adjust operating entrance door hardware to function smoothly as recommended by manufacturer.
 - 1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches from the latch, measured to the leading door edge.
- C. Clean completed system, inside and out, promptly after erection and installation of glass and sealants. Remove excess glazing and sealant compounds, dirt, and other substances from aluminum surfaces.

- D. Advise Contractor of protective treatment and other precautions required through the remainder of the construction period, to ensure that doors and frames will be without damage and deterioration (other than normal weathering) at the time of acceptance.

SECTION 08710 - DOOR HARDWARE**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Other doors to the extent indicated.
 - 2. Cylinders for doors specified in other Sections.
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames."
- C. Products furnished, but not installed, under this Section include the following.
Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
 - 1. Cylinders for locks specified in other Sections.

1.2 SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.
- C. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.
- B. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

1.5 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finish, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion, except as follows:
 - a. Exit Devices: Two years from date of Substantial Completion.
 - b. Manual Closers: 10 years from date of Substantial Completion.

1.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 PRODUCTS

2.0 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and as indicated in the Door Hardware Schedule in the drawings
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware section of the drawings. Products are identified by using door hardware designations, as follows:

2.1 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
 - 1. Two Hinges: For doors with heights up to 60 inches.
 - 2. Three Hinges: For doors with heights 61 to 90 inches.
- B. Hinge Weight: Unless otherwise indicated, provide the following:
 - 1. Entrance Doors: Heavy-weight hinges.
 - 2. Doors with Closers: Antifriction-bearing hinges.
 - 3. Interior Doors: Standard-weight hinges.
- C. Hinge Base Metal: Unless otherwise indicated, provide the following:
 - 1. Exterior Hinges: Satin Nickel, with stainless-steel pin body and Brushed Satin protruding heads.
 - 2. Interior Hinges: Satin Nickel, with stainless-steel pin body and Satin Nickel protruding heads.
- D. Hinge Options: Where indicated in door hardware sets or on Drawings:
 - 1. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for out-swinging exterior doors.
 - 2. Corners: Square.
- E. Fasteners: Comply with the following:
 - 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - 2. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.

2.2 HINGES

- A. Butts and Hinges: BHMA A156.1. Listed under Category A in BHMA's "Certified Product Directory."
 - 1. Manufacturers:
 - a. Bommer Industries, Inc
 - b. Hager
 - c. Stanley Commercial Hardware; Div. of The Stanley Works.

2.3 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbs to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- C. Lock Trim:
 - 1. Levers: Cast.
 - 2. Escutcheons (Roses): Cast.
 - 3. Lockset Designs: Provide design indicated on Drawings or, if sets are provided by another manufacturer, provide designs that match those designated.
- D. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
- E. Backset: 2-3/4 inches, unless otherwise indicated.
- F. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
 - a. Strikes for Mortise Locks and Latches: BHMA A156.13.

2.4 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
 - 1. Mortise Locks: BHMA A156.13.
- B. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13.
 - 1. Manufacturers:
 - a. Best

2.5 DOOR BOLTS

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Fire-Rated Surface Bolts: Minimum 1-inch throw; listed and labeled for fire-rated doors.
 - 2. Mortise Flush Bolts: Minimum 3/4-inch throw.
- B. Dustproof Strikes: BHMA A156.16, Grade 1.
- C. Surface Bolts: BHMA A156.16.
 - 1. Flush Bolt Heads: Minimum of 1/2-inch diameter rods of brass, bronze, or stainless steel with minimum 12-inch long rod for doors up to 84 inches in height. Provide longer rods as necessary for doors exceeding 84 inches.
 - 2. Manufacturers:
 - a. Hager Companies

- b. Stanley Commercial Hardware; Div. of The Stanley Works
 - c. Trimco
- D. Manual Flush Bolts: BHMA A156.16, Grade 1 unless Grade 2 is indicated; designed for mortising into door edge.
 - 1. Manufacturers:
 - a. Hager Companies
 - b. Stanley Commercial Hardware; Div. of The Stanley Works
 - c. Trimco

2.6 EXIT DEVICES

- A. Exit Devices: BHMA A156.3, Grade 1 unless Grade 2 is indicated. Listed under Category G in BHMA's "Certified Product Directory."
- B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
- C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- F. Outside Trim: Lever with cylinder; material and finish to match locksets, unless otherwise indicated.
 - 1. Match design for locksets and latchsets, unless otherwise indicated.
- G. Through Bolts: For exit devices and trim on metal doors and fire-rated wood doors.
- I. Manufacturers:
 - 1. Adams Rite Manufacturing Co
 - 2. Detex Corporation
 - 3. DORMA Architectural Hardware; Member of The DORMA Group North America
 - 4. Von Duprin; an Ingersoll-Rand Company

2.7 LOCK CYLINDERS

- A. Standard Lock Cylinders: BHMA A156.5, Grade 1 unless Grade 2 is indicated.
- B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 - 1. Number of Pins: Seven.
 - 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 - 3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - a. High-Security Grade: BHMA A156.5, Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Construction Keying: Comply with the following:
 - 1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

- a. Replace construction cores with permanent cores as directed by Owner.
 - b. Furnish permanent cores to Owner for installation.
- E. Manufacturer: Best.

2.8 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
 - 1. Master Key System: Cylinders are operated by a change key and a master key.
 - 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. All exterior doors shall be master keyed.
 - 2. Quantity: In addition to one extra key blank for each lock, provide the following:
 - a. Cylinder Change Keys: Three.
 - b. Master Keys: Five.
 - c. Furnish one extra blank for each lock.

2.9 OPERATING TRIM

- A. Standard: BHMA A156.6 and as illustrated on Drawings.
- B. Manufacturers:
 - 1. Hager Companies
 - 2. IVES Hardware; an Ingersoll-Rand Company
 - 3. Rockwood Manufacturing Company
 - 4. Trimco

2.10 CLOSERS

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
 - 1. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbs to set door in motion and not more than 15 lbs to open door to minimum required width.
- C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- D. Surface Closers: BHMA A156.4, Grade 1 unless Grade 2 is indicated. Listed under Category C in BHMA's "Certified Product Directory." Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
 - 1. Manufacturers:
 - a. DORMA Architectural Hardware; Member of The DORMA Group North America (DAH).
 - b. LCN Closers; an Ingersoll-Rand Company
 - c. Norton Door Controls; an ASSA ABLOY Group company

2.11 PROTECTIVE TRIM UNITS

- A. Size: 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in door hardware sets.
- B. Fasteners: Manufacturer's standard machine or self-tapping screws.
- C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from material indicated in door hardware sets.
 - 1. Manufacturers:
 - a. Hager Companies
 - b. IVES Hardware; an Ingersoll-Rand Company
 - c. Rockwood Manufacturing Company
 - d. Trimco

2.12 STOPS AND HOLDERS

- A. Stops and Bumpers: BHMA A156.16, Grade 1 unless Grade 2 is indicated.
 - 1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.
- B. Combination Floor and Wall Stops and Holders: BHMA A156.8, Grade 1 unless Grade 2 is indicated.
- C. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame.
- D. Manufacturers:
 - 1. Hager Companies
 - 2. IVES Hardware; an Ingersoll-Rand Company
 - 3. Rockwood Manufacturing Company
 - 4. Stanley Commercial Hardware; Div. of The Stanley Works
 - 5. Trimco

2.13 DOOR GASKETING

- A. Standard: BHMA A156.22, Listed under Category J in BHMA's "Certified Product Directory."
- B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- C. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- D. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: After 5 minutes into the test, neutral pressure level in furnace shall be established at 40 inches or less above the sill.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Gasketing Materials: ASTM D 2000 and AAMA 701/702.
- G. Manufacturers:
 - 1. Hager Companies
 - 2. National Guard Products
 - 3. Pemko Manufacturing Co
 - 4. Reese Enterprises
 - 5. Zero International

2.14 THRESHOLDS

- A. Standard: BHMA A156.21. Listed under Category J in BHMA's "Certified Product Directory."
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" and ANSI A117.1.
 - 1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
- C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch high.
- D. Manufacturers:
 - 1. Hager Companies (HAG).National Guard Products
 - 2. Pemko Manufacturing Co
 - 3. Reese Enterprises
 - 4. Zero International

2.15 FABRICATION

- A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- B. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Steel Machine Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - c. Closers to doors and frames.
 - 3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
 - 4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

2.16 FINISHES

- A. Standard: BHMA A156.18, Satin Nickel or as indicated in door hardware schedule in drawings
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other

components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

3.2 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated on Drawings, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

3.3 ADJUSTING

- A. Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

3.4 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

SECTION 08800 – GLASS AND GLAZING**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Glass glazed into frames (except factory glazed windows).
- B. Setting materials and cleaners.

1.1 RELATED SECTIONS

- A. Section 10820 - Toilet Accessories: For framed mirrors.

1.2 QUALITY ASSURANCE

- A. Unless otherwise shown, or governed by other reference standards specified, conform with details and procedures of the "Glazing Manual, 1986 Edition" (Flat Glass Marketing Association).
- B. American National Standard Institute (ANSI) Z97.1.
 - 1. Each piece of safety glass shall exhibit appropriate label.
- C. Consumer Product Safety Commission (CPSC), "Safety Standards for Architectural Glazing Materials".

1.3 DELIVERY, STORAGE AND HANDLING

- A. Deliver glazing materials to Project site in manufacturer's unopened containers, fully identified with trade name, color, size, hardness, type, class, and grade. Store each item in accordance with manufacturer's instructions. Damaged and otherwise unsuitable material, when so determined, shall be immediately removed from the Project site.

1.4 PROJECT CONDITIONS

- A. Maintain a minimum temperature of 40 degrees F. during glazing unless the manufacturer of the glazing materials specifically agrees to installation of specified materials at lower temperatures. If job progress and other conditions require glazing work when temperatures are below 40 degrees F. (or below the minimum temperature recommended by the manufacturer), consult the manufacturer and establish the minimum provisions required to ensure satisfactory work. Record in writing to the manufacturer, with copy to the Owner's Construction Manager, the conditions under which such glazing work proceeds, and the provisions made to ensure satisfactory work.

1.5 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Exterior Wind and Impact Loading: Provide exterior glass to withstand wind loading pressures in accordance with the following
- C. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour at 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 6.5, "Method 2-Analytical Procedure," based on mean roof heights above grade indicated on Drawings.
 - b. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.
 - 1) Load Duration: 60 seconds or less.
 - c. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.
 - 1) For insulating glass.
 - d. In areas required to meet hurricane exterior wind and impact loading requirements, provide exterior glass to withstand wind loading pressures in accordance with the following:
 - 1) Provide products meeting the design pressure requirements indicated in the wind tunnel study, RWDI 06-1081.
 - 2) Provide products having a current Dade County (Florida) Notice of Acceptance (NOA).
- D. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:
 1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 2. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:
 - a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
 - b. Solar Heat Gain Coefficient: NFRC 200.
 - c. Solar Optical Properties: NFRC 300.

1.9 WARRANTY

- A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: 10-years from date of Substantial Completion.

PART 2 PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

- A. Primary Glass Products and Insulated Units:
 1. Cardinal IG
 2. Falconer Glass Industries, Inc.
 3. Ford Motor Co., Glass Div.
 4. Guardian Industries, Corp.

5. Libbey-Owens-Ford Co.
 6. PPG Industries, Inc. Glass Group
 7. Viracon, Inc.
 8. Tempglass, Inc.
- B. Other Materials - As specified in Article 2.02.

2.1 MATERIALS

- A. Clear Float Glass: ASTM C1036 Type 1, Class 1 Quality q3, 1/4" thick clear.
- B. Colored Plate Glass: ASTM C1036, 1/4" thick, graylite #14.
- C. Tempered Float Glass: Float glass which has been heat strengthened (fully tempered) to achieve strength 4 to 5 times stronger than regular annealed glass, complying with ASTM C1048 and ANSI-Z97.1. Glass shall be tempered horizontally. (Tong marks at top only will be permitted).
- D. Insulating Glass: 1" insulating glass complying with ASTM E774 as tested and approved in accordance with SIGMA, Sealed Insulating Glass Manufacturers Association requirements. Provide following where shown:
 1. Type A: 1/4" clear glass outboard, 1/2" air space and 1/4" clear glass inboard.
 - a. Temper both panes where shown on Drawings and/or as required.
- E. GLAZING GASKETS
 1. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
 - a. Neoprene, ASTM C 864.
 - b. EPDM, ASTM C 864.
 - c. Thermoplastic polyolefin rubber, ASTM C 1115.
 - d. Any material indicated above.
 2. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
 - a. Neoprene.
 - b. EPDM.
 - c. Thermoplastic polyolefin rubber.
 - d. Any material indicated above.
- F. GLAZING SEALANTS
 1. General: Provide products of type indicated, complying with the following requirements:
 - a. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - b. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - c. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - d. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
 2. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
 - a. Single-Component Neutral and Basic Curing Silicone Glazing Sealants:
 - 1) Products:

- 2) Dow Corning Corporation; 790.
- 3) GE Silicones; SilPruf LM SCS2700.
- 4) Tremco; Spectrem 1 (Basic).
- 5) Sonneborn, Div. of ChemRex, Inc.; Omniseal.
 - b. Type and Grade: S (single component) and NS (non-sag).
 - c. Class: 50.
 - d. Use Related to Exposure: NT (non-traffic).
 - e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.
 - 1) Use O Glazing Substrates: Anodic aluminum.

G. GLAZING TAPES

1. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - a. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - b. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
2. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 - a. Type 1, for glazing applications in which tape acts as the primary sealant.
 - b. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

H. MISCELLANEOUS GLAZING MATERIALS

1. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
3. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
4. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
5. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
6. Cleaners: Type recommended by gasket manufacturer.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine the framing and glazing channel surfaces, backing, removable stop design, and the conditions under which the glazing is to be performed, and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the glazing until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Measure openings and cut glass accurately to fit each opening with minimum edge clearances and bite on glass as specified by FGMA. If glass is to be cut to size at Project

site, deliver each piece to Project at least 2" larger (in both dimensions) than required, to facilitate the cutting of clean-cut edges without the necessity of seaming and nipping.

1. Do not attempt to cut, seam, nip, and abrade glass which is tempered, heat strengthened, and coated.
- B. Clean glazing stops and rabbets to receive glazing materials of obstructions and deleterious substances which might impair the work.

3.2 INSTALLATION

A. PREPARATION

1. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. GLAZING, GENERAL

1. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
2. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
3. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
4. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
5. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
6. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
7. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:
 - a. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - b. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
8. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
9. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
10. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner and butt joints with sealant recommended by gasket manufacturer.

C. TAPE GLAZING

1. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
2. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

3. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
 4. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
 5. Do not remove release paper from tape until just before each glazing unit is installed.
 6. Apply heel bead of elastomeric sealant.
 7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
 8. Apply cap bead of elastomeric sealant over exposed edge of tape.
- D. GASKET GLAZING (DRY)
1. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
 2. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 3. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 4. Install gaskets so they protrude past face of glazing stops.
- E. SEALANT GLAZING (WET)
1. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
 2. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
 3. Tool exposed surfaces of sealants to provide a substantial wash away from glass.
- F. LOCK-STRIP GASKET GLAZING
- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system, unless otherwise indicated.

3.3 ADJUSTING AND CLEANING

- A. Protect glass from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Warning markings shall not be applied directly to the glass.
- B. Remove and replace glass which is broken, cracked, chipped, or damaged in any way and from any source, including vandalism and accidents during the construction period.
- C. Maintain glass in a reasonably clean condition during construction so that it will not become stained.
- D. Wash and polish glass on all faces just prior to final acceptance. Comply with instructions and recommendations of the glass manufacturer for cleaning.

SECTION 09220 - PORTLAND CEMENT PLASTERING**PART 1- GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior Portland cement plasterwork (stucco) on metal lath and solid plaster bases.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for wood framing included in Portland cement plaster assemblies.
 - 2. Division 06 Section "Sheathing" for sheathing and water-resistant barriers included in Portland cement plaster assemblies
 - 3. Division 07 Section "Joint Sealants" for sealants installed with exterior Portland cement plaster (stucco).

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each type of colored and textured finish coat indicated; 12 by 12 inches, and prepared on rigid backing.

1.3 QUALITY ASSURANCE

- A. Mockups: Before plastering, install mockups of at least 32 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for each type of finish indicated.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.5 PROJECT CONDITIONS

- A. Comply with ASTM C 926 requirements.
- B. Exterior Plasterwork:
 - 1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.
 - 2. Apply plaster when ambient temperature is greater than 40 deg F.
 - 3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.
- C. Factory-Prepared Finishes: Comply with manufacturer's written recommendations for environmental conditions for applying finishes.

PART 2- PRODUCTS**2.0 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 METAL LATH

- A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653, G60, hot-dip galvanized zinc coating.
 - 1. Manufacturers:
 - a. Dale/Incor.
 - b. Dietrich Industries, Inc.
 - c. Marino/Ware; Division of Ware Industries, Inc.
 - d. Unimast, Inc.
 - e. Western Metal Lath & Steel Framing Systems.
 - 2. Diamond-Mesh Lath: Flat.
 - a. Weight: 2.5 lb/sq. yd.
 - 3. Flat Rib Lath: Rib depth of not more than 1/8 inch.
 - a. Weight: 2.75 lb/sq. yd.
- B. Paper Backing: FS UU-B-790, Type I Grade D, Style 2 vapor-permeable paper.
 - 1. Provide paper-backed lath, unless otherwise indicated.

2.2 ACCESSORIES

- A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.
- B. Zinc and Zinc-Coated (Galvanized) Accessories:
 - 1. Manufacturers:
 - a. Dale/Incor.
 - b. Dietrich Industries, Inc.
 - c. Marino/Ware; Division of Ware Industries, Inc.
 - d. Unimast, Inc.
 - e. Western Metal Lath & Steel Framing Systems.
 - 2. Foundation Weep Screed: Fabricated from hot-dip galvanized steel sheet, ASTM A 653, G60 zinc coating.
 - 3. Cornerite: Fabricated from metal lath with ASTM A 653, G60, hot-dip galvanized zinc coating.
 - 4. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653, G60, hot-dip galvanized zinc coating.
 - 5. Corner-beads: Fabricated from zinc-coated (galvanized) steel.
 - a. Small nose corner-bead with expanded flanges; use unless otherwise indicated.
 - 6. Casing Beads: Fabricated from zinc-coated (galvanized) steel; square-edged style; with expanded flanges.
 - 7. Control Joints: Fabricated from zinc-coated (galvanized) steel; one-piece-type, folded pair of un-perforated screeds in M-shaped configuration; with perforated flanges and removable protective tape on plaster face of control joint.

2.3 MISCELLANEOUS MATERIALS

- A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.
- B. Fiber for Base Coat: Alkaline-resistant glass or polypropylene fibers, 1/2 inch long, free of contaminants, manufactured for use in Portland cement plaster.
- C. Bonding Compound: ASTM C 932.
- D. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of not fewer than three exposed threads.
- E. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.
- F. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing), produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 - 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2.4 PLASTER MATERIALS

- A. Portland Cement: ASTM C 150, Type I.
 - 1. Color for Finish Coats: Gray.
- B. Colorants for Job-Mixed Finish-Coats: Colorfast mineral pigments that produce finish plaster color to match Architect's sample.
- C. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.
- D. Sand Aggregate: ASTM C 897.
 - 1. Color for Job-Mixed Finish Coats: In color matching Architect's sample.
- E. Ready-Mixed Finish-Coat Plaster: Mill-mixed Portland cement, aggregates, coloring agents, and proprietary ingredients.
 - 1. Products:
 - a. California Stucco Products Corp.; Conventional Portland Cement Stucco.
 - b. ChemRex; Thoro Stucco.
 - c. Highland Stucco & Lime Products, Inc.
 - d. United States Gypsum Co.; Oriental Exterior Finish Stucco.
 - 2. Color and texture: As selected by Owner from manufacturer's full range.

2.5 PLASTER MIXES

- A. General: Comply with ASTM C 926 for applications indicated.
 - 1. Fiber Content: Add fiber to base-coat mixes after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. yd. of cementitious materials. Reduce aggregate quantities accordingly to maintain workability.
- B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:
 - 1. Portland Cement Mixes:
 - a. Scratch Coat: For cementitious material, mix 1 part Portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).
 - b. Brown Coat: For cementitious material, mix 1 part Portland cement and 3/4 to 1-1/2 parts lime. Use 3 to 5 parts aggregate per part of cementitious material (sum of separate volumes of each component material).
- C. Base-Coat Mixes for Use over Concrete Unit Masonry: Single base coats for two-coat plasterwork as follows:
 - 1. Portland Cement Mix: For cementitious material, mix 1 part Portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).
 - 2. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.

- a. Plastic Cement Mix: Use 1 part plastic cement and 2-1/2 to 4 parts aggregate
- D. Job-Mixed Finish-Coat Mixes:
 - 1. Portland Cement Mix: For cementitious materials, mix 1 part Portland cement and 3/4 to 1-1/2 parts lime. Use 1-1/2 to 3 parts aggregate per part of cementitious material (sum of separate volumes of each component material).
- E. Factory-Prepared Finish-Coat Mixes: For ready-mixed finish-coat plasters, comply with manufacturer's written instructions.

PART 3- EXECUTION

3.0 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

3.2 INSTALLING METAL LATH

- A. Expanded-Metal Lath: Install according to ASTM C 1063.
 - 1. Partition Framing and Vertical Furring: Install flat diamond-mesh lath.
 - 2. On Solid Surfaces, Not Otherwise Furred: Install self-furring diamond-mesh lath.

3.3 INSTALLING ACCESSORIES

- A. Install according to ASTM C 1063 and at locations indicated on Drawings.
- B. Reinforcement for External Corners:
 - 1. Install lath-type external-corner reinforcement at exterior locations.
 - 2. Install corner-bead at exterior locations.
- C. Control Joints: Install control joints at locations indicated on Drawings, if not indicated on Drawings, in specific locations approved by Architect for visual effect as follows:
 - 1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:
 - a. Vertical Surfaces: 144 sq. ft.
 - b. Horizontal and other Non-vertical Surfaces: 100 sq. ft.
 - 2. At distances between control joints of not greater than 18 feet o.c.
 - 3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.
 - 4. Where control joints occur in surface of construction directly behind plaster.
 - 5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.4 PLASTER APPLICATION

- A. General: Comply with ASTM C 926.
 - 1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.
 - 2. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Except where full

grouting is indicated or required for fire-resistance rating, grout at least 6 inches at each jamb anchor.

3. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.
 4. Provide plaster surfaces that are ready to receive field-applied finishes indicated.
- B. Plaster Finish Coats: Apply to provide float finish to match Owner's sample.

3.5 CUTTING AND PATCHING

- A. Cut, patch, replace, and repair plaster as necessary to accommodate other work and to restore cracks, dents, and imperfections. Repair or replace work to eliminate blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protection and enclosure of other work. Promptly remove plaster from doorframes, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

SECTION 09250 – GYPSUM WALLBOARD**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Non-load bearing steel studs.
- B. Gypsum wallboard.
- C. Metal suspension system.
- D. Accessories and joint materials.

1.1 RELATED SECTIONS

- A. Section 06100 – Rough Carpentry
- B. Section 09300- Ceramic Tile

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description and recommended installation instructions for systems used.

1.3 QUALITY ASSURANCE

- A. Gypsum wallboard construction shall comply with laws, ordinances, rules, regulations and orders of governing authorities having jurisdiction over this part of the Work.
- B. To the greatest extent possible, obtain materials from 1 (one) manufacturer to promote single source responsibility.
- C. Where gypsum drywall systems with fire-resistance ratings are indicated and where required to comply with governing regulations, provide materials and installations identical with applicable assemblies which have been tested and listed by recognized authorities, including UL., FM and A.I.A.
- D. Comply with the provisions of the following codes, specifications and standards except where more stringent requirements are shown on the Drawings or specified herein:
 - 1. Gypsum Association (GA) "Recommended Specifications for the Application and Finishing of Gypsum Wallboard," GA-216, unless otherwise specified herein.
 - 2. Gypsum Association (GA) "Recommended Specification: Levels of Gypsum Board Finish" GA-214 jointly published by AWCI, CISCA, GA, and PDCA.
 - 3. ASTM C645 "Standard Specification for Non-Load (Axial) Bearing Steel Studs, Runners (Track), and Rigid Furring Channels for Screw Application of Gypsum Board".
 - 4. ASTM C754 "Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum".

1.4 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered to the Project site in their original, unopened containers or bundles and stored in a place providing protection from damage and exposure to the elements. Damaged and otherwise unsuitable material, when so determined, shall be immediately removed from the Project site.

1.5 PROJECT CONDITIONS

- A. For non-adhesive attachment of gypsum board to framing, maintain not less than 40 degrees F. For adhesive attachment and finishing of gypsum board maintain not less than 50 degrees F. for 48 hours prior to application and continuously thereafter until drying is complete. Installation shall not be started until windows are glazed, doors

installed and openings temporarily closed. Ventilation shall be provided to remove excess moisture during joint treatment.

PART 2 PRODUCTS

2.0 MATERIALS

- A. Gypsum Wallboard: Tapered edge, 5/8" thick.
 - 1. Regular: ASTM C36
 - a. Provide high-abuse as noted on drawings.
 - 2. Type X (Fire rated): ASTM C36
 - 3. Water-Resistant Gypsum Wallboard: ASTM C 630, and as follows:
 - a. Type: Regular, unless otherwise indicated.
 - b. Thickness: 5/8" unless otherwise specified.
- B. Screws: Type S and S-12 buglehead and panhead, sized to suit thickness.
 - 1. Corrosion resistant treated, or stainless steel.
- C. Adhesive: As recommended by the gypsum wallboard manufacturer.
- D. Backer Plates: 20 gauge, galvanized per ASTM B633, Type RS or heavier, sizes as required, for fastening to channels for attachment of fixtures, accessories, and similar items. Refer to Drawings, provide solid wood blocking if so indicated.
- E. Accessories: Corner reinforcements, casing beads and metal trim, fabricated from .012" (minimum) galvanized sheet steel with perforated flanges, designed to receive joint compound.
- F. Control Joints: Roll-formed zinc, or extruded vinyl as standard with the wallboard manufacturer.
- G. Joint Treatment Materials: ASTM C475.

2.1 MANUFACTURERS

- A. Steel Framed Gypsum Drywall:
 - 1. "Gypsum Wallboard" (Georgia-Pacific Corp.).
 - 2. "Gypsum Wallboard Construction" (Gold Bond Building Products Div., National Gypsum Co.).
 - 3. "Gypsum Drywall" (United States Gypsum Co., USG Corp.).

PART 3 EXECUTION

3.0 INSTALLATION

- A. Wallboard:
 - 1. Install acoustical insulation as indicated, prior to gypsum board unless readily installed after board has been installed.
 - 2. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 1' -0" in alternate courses of board.
 - 3. Install ceiling boards in the direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of each ceiling. Stagger end joints at least 1' -0".
 - 4. Install wall/partition boards perpendicular to framing (long edges of board perpendicular to framing members).
 - a. Where double-layer application is shown for fire-resistive rated assemblies, fasten both base layers and face layers separately to supports with screws. Install base layer perpendicular to framing members and face layer parallel to framing member.
 - b. Gypsum board joints at openings shall be located so that no joint will align with edges of opening unless control joints will be installed at these points.

5. Install exposed gypsum board with face side out. Do not install imperfect, damaged and damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16" open space between boards. Do not force into place.
 6. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field cut ends. not place tapered edges against cut edges and ends. Stagger vertical joints over different studs on opposite sides of partitions.
 7. Attach gypsum board to framing and blocking as required for additional support at openings and cutouts.
 8. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories.
 9. Cover both faces of steel stud partition framing with gypsum board in concealed spaces (e.g. above ceilings).
 10. Space fasteners in gypsum boards in accordance with GA-216 and manufacturer's recommendations, except as otherwise indicated.
 11. Wall Tile Base: Where drywall is base for thin-set ceramic tile and similar rigid applied wall finishes, install water resistant gypsum wallboard.
 12. Install gypsum board to radiused surfaces furring or framing in accordance with manufacturers recommendations for thicknesses shown. Moistening the face and back papers thoroughly allowing water to soak into the core of the board may be used as a method to obtain radii shorter than published recommendations.
 13. Laminate gypsum wallboard to masonry and concrete surfaces in accordance with wallboard manufacturer's instructions using recommended adhesives.
- B. Accessories:
1. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations
 - a. Install metal corner beads at external corners of drywall work.
 - b. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed, and except where plastic trim is indicated. Provide type with face flange to receive joint compound except where semi-finishing type is indicated.
- C. Wallboard Finishing:
1. General: Apply treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required to prepare work for decoration. Prefill open joints, rounded and beveled edges, if any, using type of compound recommended by manufacturer.
 - a. Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.
 - b. Sand after last coat, between coats if necessary to produce desired finish.
 - c. Wallboard finishing including joint treatment and nail or screw dimple treatment shall be complete to finished floor.
 2. Levels of finishing shall comply with those established by reference in GA-214.

3.1 PROTECTION

- A. Advise Contractor of required procedures for protecting gypsum drywall work from damage and deterioration during remainder of construction period.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet, moisture, or mold damaged include, but are not limited to, discoloration, sagging, fuzzy or irregular shape.

SECTION 09300 - TILE**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Ceramic wall tile and floor tile.
- B. Quarry tile floor and base.
- C. Installation accessories.

1.1 RELATED SECTIONS

- A. Section 07900 - Sealants.

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description and recommended installation instructions for adhesives, manufactured mortar, grout and latex additive.
 - 2. Samples: Samples of each type tile through range of color.
 - 3. Submit tile manufacturer's maintenance guidelines for Owner's use in maintaining tile work herein specified.

1.3 QUALITY ASSURANCE

- A. Material and installation shall comply with following:
 - 1. Tile Council of America Inc.:
 - a. 1992 Handbook for Ceramic Tile Installation.
 - 2. Engineered ceramic tile, standard grade, ANSI A137.1 and as specified.
 - 3. American National Standards Institute Specifications for:
 - a. Glazed Wall Tile, Ceramic Mosaic Tile, Quarry Tile and Paver Tile Installed with Portland Cement Mortar, A108.1.
 - b. Ceramic Tile Installed with Water-Resistant Organic Adhesives or Water-Cleanable Tile Setting Epoxy Adhesive A108.4.
 - c. Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar, A108.5.
 - d. Dry-Set Portland Cement Mortar, A118.1.
 - e. Latex-Portland Cement Mortar, A118.4.
 - f. Ceramic Tile Grouts, A118.6.
 - g. Organic Adhesives for Installation of Ceramic Tile A136.1.
 - h. Ceramic Tile, A137.1.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Accept delivery of material only in an undamaged condition; store above ground and in a dry place within the building. Packaged material shall be in original containers with seals unbroken and labels intact until time of use. Wrapped or bundled material shall bear the name of the manufacturer and the product. Damaged and otherwise unsuitable material, when so determined, shall be immediately removed from the Project site.

1.5 PROJECT CONDITIONS

- A. Maintain temperature within spaces scheduled to receive tile at 50 degrees F. (minimum) during installation and for 7 days following completion.

- B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

PART 2 PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

- A. For Ceramic Tile:
 - 1. United States Ceramic Tile Co.
- B. For Unglazed Quarry Tile:
 - 1. American Olean Tile Co.
 - 2. Huntington/Pacific Ceramics, Inc.
 - 3. Mid-State Tile Co.
 - 4. Quarry Tile Co.
 - 5. Summitville Tiles, Inc.

2.1 MATERIALS

- A. Ceramic Tile Walls: Unglazed tile, standard grade square edge, unless otherwise shown on drawings.
 - 1. Size: As indicated in drawings
 - 2. Trim: Sizes and shapes as required.
 - 3. Color: As indicated in drawings
- B. Quarry Tile Floors: Unglazed natural clay quarry tile square edged with standard finish, unless otherwise shown on drawings.
 - 1. Size: As indicated in drawings
 - 2. Trim: Sizes and shapes as required.
 - 3. Color: As indicated in drawings
- C. Portland Cement: ASTM C150-85a, Type 1.
- D. Hydrated Lime: ASTM C206-84 Type S or ASTM C207-79 (1984) Type S.
- E. Sand: ASTM C144-87.
- F. Dry-Set Mortar: ANSI 118.1
- G. Latex Portland Cement Mortar: ANSI 118.4
- H. Ceramic Tile Adhesive: CS 181-52
- I. Latex Liquid Additives:
 - 1. Type 1 (For Mortar-Typical): "Laticrete" No. 4237 (Laticrete International, Inc.); "TEC Crete" No. TA-870 (TEC, an HB Fuller Company)
 - 2. Type 2 (For Grout-Typical): "Laticrete" No. 3701 (Laticrete International, Inc.); "TEC Tile Bond" No. TA-815 (TEC, an HB Fuller Company).
- J. Marble Thresholds: If specified in drawings, provide Sound Group "A" marble with an abrasive hardness of not less than 10.0 when tested in accordance with ASTM C241.

2.2 SETTING BEDS

- A. Floor Setting Beds:
 - 1. Over Slab-On-Grade:
 - A. Latex-Portland Cement Mortar: 1 part portland cement, 1 part fine dry sand and latex liquid added in lieu of water to produce a workable mix.
- B. Wall Setting Beds:
 - 1. Over Gypsum Wallboard:
 - a. Latex-Portland Cement Mortar: 1 part portland cement, 1 part fine dry sand and latex liquid added in lieu of water to produce a workable mix.
- C. Grout:
 - 1. Dry-Set Grout: Factory pre-mix with water added in accordance with the manufacturer's recommendations.

2. Latex-Portland Cement Grout: Sand-portland cement grout, or dry-set grout, with latex liquid added in lieu of water to produce a workable mix.
 - a. Dry-set grout with latex liquid only, is approved for use in grouting tile set over gypsum concrete floor underlayment.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine the areas and conditions under which the work is to be performed and notify the Owner, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Work shall not commence until grounds, anchors, plugs, hangers, bucks, etc., have been installed, and until adjoining work is satisfactorily protected
- B. Layout tile in each area in such a manner as to minimize the cutting of tile.
 1. Locate cuts in both walls and floors so as to be least conspicuous.
 2. Align all wall joints to give straight uniform grout lines, plumb and level.
 3. Align all floor joints with grout joints.

3.2 INSTALLATION OF FLOOR TILE AND BASE

- A. Concrete Subfloor (Slab-On-Grade): Latex-Portland Cement Mortar, TCA Method F113-92.
- B. Tile layout should begin at intersection of concrete slab control joints.
- C. Construct expansion or control joints by installing wood strips extending through setting bed. Width of such joints shall be as shown but not less than 1/8" for ceramic tile and 1/4" for quarry tile. If locations of such joints are not shown they shall occur at restraining surfaces, such as walls, curbs, columns, pipes, etc. In large interior tiled areas expansion joints shall occur not more than 36 ft. o.c. each way. After tile has set for three days, remove the wood strips, clean and repair the joints with sealants as indicated in Section 07900.
- D. Setting Base:
 1. Install base with latex-portland cement mortar, directly to substrate. Apply mortar with the flat side of trowel and comb with the serrated or notched side of trowel. Press the base firmly into place and tap lightly to ensure maximum bond. Joints of the base shall be of the same width and align with the joints of the floor tile insofar as practicable.

3.3 INSTALLATION OF MISCELLANEOUS ITEMS

- A. Install marble thresholds at locations indicated set in same type of setting bed as abutting field tile unless otherwise indicated.
 1. Set thresholds in thinset mortar for locations, where mortar bed would otherwise be exposed above adjacent non-tile floor finish.

3.4 GROUTING

- A. After tile is firmly set, fill joints with latex-portland cement grout. Spread slurry of grout over the floor surfaces until joints are filled. On walls, after tile has set, remove string or rope spacers, if any, and force a maximum of grout into joints by trowel, squeegee, brush, or finger application. Use latex-portland cement grout in joints of tile set with organic adhesive. Fill joints flush with surface of tile. Before grout sets, fill all skips and

gaps. Tool joints to cushion edge of tile except joints in quarry tile shall be struck flush. Remove surface latence and excess grout with dry polishing cloths. Face of all tile shall be left clean and free from grout or other stains.

3.5 ADJUSTING AND CLEANING

- A. Upon completion of tile work in each area, including work specified under other Section, clean all tile surfaces with warm water and high quality washing compound. Acid or acid cleaners **shall not** be used. Sponge and wash tile thoroughly, working diagonally across joints; polish with dry cloths.
- B. Prohibit all foot and wheel traffic from using newly tiled floors for at least 3 days following completion.
- C. Immediately prior to occupancy by the Owner, power wash tile surfaces and perform additional grouting that may be necessary.

3.6 PROTECTION

- A. Tile floors shall be covered with non-staining building paper until just prior to occupancy by the Owner. During construction, tiled areas used as walkways, in addition to other covering shall be protected.

3.7 EXTRA STOCK

- A. Furnish Owner at least 2 percent additional tile of each type used on this project over and above the amount installed.
- B. Deliver to Owner at time of final inspection of work under this Section and store where directed in the building.

SECTION 09510 - ACOUSTIC PANEL CEILINGS**PART 1 GENERAL****1.1 GENERAL REQUIREMENTS**

- A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment and services necessary to complete the acoustic panel ceilings as shown on the drawings and/or specified herein, including but not limited to, the following:
 - 1. Acoustical panel units.
 - 2. Exposed "T" suspension system, including hangers and inserts.
 - 3. Provisions for the installation of lighting fixtures, diffusers, grilles and similar items provided under other Sections.
 - 4. Cutting, drilling, scribing and fitting as required for electro-mechanical penetrations.
 - 5. Perimeter and column moldings, trim and accessories for acoustical ceilings.

1.3 RELATED SECTIONS

- A. Section 05310 - Steel Deck.
- B. Section 09250 - Gypsum Wallboard, for drywall ceilings.
- C. Division 23 - Diffusers, grilles and related frames.
- D. Division 26 - Lighting fixtures.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with all pertinent recommendations published by the Ceilings and Interior Systems Construction Association (CISCA).
- B. Qualifications of Installers
 - 1. The suspended ceiling subcontractor shall have a record of successful installation of similar ceilings acceptable to Architect and shall be currently approved by the manufacturer of the ceiling suspension system.
 - 2. For the actual fabrication and installation of all components of the system, use only personnel who are thoroughly trained and experienced in the skills required and completely familiar with the requirements established for this work.
- C. The work is subject to the following standards:
 - 1. ASTM C 635 "Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings," American Society for Testing and Materials.
 - 2. ASTM C 636 "Standard Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels," American Society for Testing and Materials.
- D. In addition to suspension system specified, provide seismic struts and seismic clips to meet seismic standards as required by prevailing Codes and Ordinances.

1.5 SUBMITTALS

- A. Shop Drawings: Submit completely dimensioned ceiling layouts for all areas where acoustical ceilings are required, showing:
 - 1. Any deviations from Architect's reflected ceiling plan layouts, especially lighting fixture and dimensions. Also indicate if any light fixtures will not fit into Architect's ceiling layout due to dimensional restrictions of field conditions.

2. Direction and spacing of suspension members and location of hangers for carrying suspension members.
3. Direction, sizes and types of acoustical units, showing suspension grid members, and starting point for each individual ceiling area.
4. Moldings at perimeter of ceiling, at columns and elsewhere as required due to penetrations or exposure at edge of ceiling tiles.
5. Location and direction of lights, air diffusers, air slots, and similar items in the ceiling plane.
6. Details of construction and installation at all conditions.
7. Materials, gauges, thickness and finishes.
- B. Samples and Product Literature: Submit the following samples and related manufacturer's descriptive literature.
 1. Twelve (12) inch long sample of each components of suspension systems, including moldings.
 2. Acoustical units - full size.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.
- B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

- A. Do not install acoustical ceilings until wet-work in space is completed and nominally dry, work above ceilings has been completed, and ambient conditions of temperature and humidity will be continuously maintained at values near those indicated for final occupancy.

1.8 COORDINATION

- A. Coordinate layout and installation of acoustical ceiling units and suspension system components with other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment, fire suppression system components, and partition system.

1.9 EXTRA STOCK

- A. Extra Stock: Deliver stock of maintenance material to Owner. Furnish maintenance material matching products installed, packaged with protective covering for storage and identified with appropriate labels.
 1. Acoustical Ceiling Units: Furnish quantity of full size units equal to 2.0% of amount installed.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

- A. Provide 3/4" thick, 24" x 24" mineral fiber panels equal to "Cirrus," No. 574 with square edge, as manufactured by Armstrong World Industries, or equal made by Roxul Rockfon or USG Interiors, Inc. Panels shall have factory applied white finish with light reflectance value of 0.83. Panels shall meet ASTM E 1264, Type III, Form 1, Pattern E I, Class A, with a UL flame spread rating of 0-25.

2.2 SUSPENSION SYSTEM

- A. Provide exposed "T" suspension system, steel, with low sheen white baked enamel finish equal to "Prelude," 15/16" exposed tee 2-way grid system made by Armstrong World Industries, or equal made by USG Interiors, Inc. or Chicago Metallic Corp.
- B. The suspension system shall support the ceiling assembly shown on the drawings and specified herein, with a maximum deflection of 1/360 of the span, in accordance with ASTM C 635.
- C. Provide min. 12 ga. galvanized wire hangers, soft annealed steel conforming to ASTM A 641, prestretched, Class 1 zinc coating, soft temper, size so that stress at 3 times hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than yield stress of wire.
- D. Provide ceiling clips and inserts to receive hangers, type as recommended by suspension system manufacturer, sizes for pull-out resistance of not less than five (5) times the hanger design load, as indicated in ASTM C 635.
- E. Suspension systems shall conform to ASTM C 635, intermediate duty.
- F. Provide manufacturer's standard wall moldings with off-white baked enamel finish to match suspension systems. For circular penetrations of ceilings, provide edge moldings fabricated to diameter required to fit penetration exactly.

PART 3 EXECUTION**3.1 INSPECTION**

- A. Examine the areas where acoustic panel ceilings are to be installed and correct any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected to permit proper installation of the layout.

3.2 PREPARATION

- A. Coordination: Furnish layouts for inserts, clips, or other supports required to be installed by other trades for support of acoustical ceilings.
- B. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less-than-half width units at borders, and comply with reflected ceiling plans.

3.3 INSTALLATION

- A. Codes and Standards: Install materials in accordance with manufacturer's printed instructions, and to comply with governing regulations and industry standards.
- B. Install suspension systems to comply with ASTM C 636, with wire hangers supported only from building structural members. Locate hangers not more than 6" from each end and spaced 4'-0" along direct-hung runner, leveling to tolerance of 1/8" in 12'-0".
- C. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail with age or elevated temperatures.
- D. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum which are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, reinforcing, countersplaying or other equally effective means.
- E. Install edge moldings at edges of each acoustical ceiling area, and at locations where edge of acoustical units would otherwise be exposed after completion of the work.
 - 1. Secure moldings to building construction by fastening through vertical leg. Space holes not more than 3" from each end and not more than sixteen (16) inches o.c. between end holes. Fasten tight against vertical surfaces.

- 2. Level moldings with ceiling suspension system, to a level tolerance of 1/8" in 12'-0".
- F. Install acoustical units in coordination with suspension system, with edges concealed by support of suspension members. Scribe and cut panels to fit accurately at borders and at penetrations.
- G. Install hold-down clips in toilet areas, and in areas where required by governing regulations; space 2'-0" o.c. on all cross tees.
- H. Light fixtures or other ceiling apparatus shall not be supported from main beams or cross tees if their weight causes the total load to exceed the deflection capability of the ceiling suspension system. In such cases the load shall be supported by supplemental hangers furnished and installed by this Section of work.
- I. Where fixture or ceiling apparatus installation causes eccentric loading on runners, provide stabilizer bars to prevent rotation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed surfaces of acoustical ceilings, including trim, edge molding, and suspension members; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

SECTION 09650 – RESILIENT TILE FLOORING**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Vinyl flooring
- B. Vinyl base.
- C. Accessories.
- D. Patching compound, adhesives, and wax.

1.1 SUBMITTALS

- A. Submit the following in accordance with Section 01340:
 - 1. Manufacturer's Literature: Materials description, installation and maintenance instructions.
 - 2. Samples: 12" length of each style base in colors selected.

1.2 QUALITY ASSURANCE

- A. Material shall comply with Federal specifications: SS-T-312B(1), Type IV, Composition 1

1.3 DELIVERY, HANDLING AND STORAGE

- A. Space temperature shall not be less than 70 degrees F. nor more than 90 degrees F. Damaged and otherwise unsuitable material when so determined, shall be immediately removed from the Project site.

1.4 PROJECT CONDITIONS

- A. Environmental Conditions:
 - 1. Spaces to receive base materials shall be at a minimum temperature of 70 degrees F.; this temperature shall be maintained during the installation, and for not less than 48 hours after installation.
 - 2. When solvent-based adhesives are used, the space shall be ventilated; use spark proof fans if natural ventilation is inadequate. Prohibit smoking.

PART 2 PRODUCTS**2.0 MANUFACTURER**

- A. Resilient Flooring: Vinyl composition tile (VCT): Armstrong
- B. Vinyl Base: Roppe

2.1 MATERIALS

- A. Resilient Flooring: Vinyl composition tile, 12" x 12" x 1/8", Armstrong 51910
 - 1. Color: Classic Black
- B. Vinyl Base: Roppe 700 series vinyl base, 4" high unless otherwise shown.
 - 1. Color: Black
 - 2. Outside corners to be preformed.
- C. Adhesive: Water and alkali resistant, water-based/rubber-resin, S-750 adhesive for resilient tile, complying with recommendations of resilient flooring manufacturer.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine the areas and conditions under which the work is to be performed and notify the Contractor, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install all material in accordance with the manufacturer's recommendations, unless otherwise specified.
- B. Mix and apply adhesive as recommended by the manufacturer. Cover surface evenly.
- C. Firmly adhere resilient base to walls and permanent bases. Use longest lengths practical. Form internal and external corners and end stops with preformed units. Inside corners may be hand formed if method is demonstrated and approved. Scribe bases accurately to abutting surfaces. On masonry surfaces, or other similar irregular vertical substrates, fill voids along top edge of base with manufacturer's recommended adhesive filler.
- D. Utilize preformed outside corners
- E. Remove excessive adhesive in accordance with manufacturer's instructions.

3.2 ADJUSTING AND CLEANING

- A. Not less than 4 days after flooring installation, clean the resilient flooring and base. Wash thoroughly, with a cleaner recommended by the manufacturer, in accordance with manufacturer's recommendations.

SECTION 09651 – EPOXY FLOORING

PART 1 GENERAL

1.0 SUMMARY

- A. Includes the furnishing of all materials, labor, tools and equipment required for the installation of the epoxy floors for the pit floor and storeroom floor and as indicated on the drawings.
 - 1. This floor covering is indicated on the Room Finish Schedule in the Architectural Drawings

1.1 RELATED WORK

- A. Section 04200 Masonry
- B. Section 09250 Gypsum Walls
- C. Section 09920 Interior Painting

1.2 SAMPLES

- A. Submit 4"x4" samples that depict the end product finish, including several anti-slip options. Provide manufacturing data all in accordance with Section 01340.

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. Truco, Inc.: Contact 216-631-1000

2.1 MATERIALS

- A. Epox-o-lon

2.2 COVERAGE

- A. Concrete: 2 coats recommended, both coats 350-400 sq. ft. per gallon (Depending on porosity).

2.3 DRY TIME

- A. Dries to touch in 4 hours, dries hard in 24 hours. Recoat 12—24 hours. Do not thin unless recommended.

2.4.1 COMPOSITION

- A. 100% epoxy resin and china-wood oil base. EPOX-O-LON is pale in color and 40% solids by volume.

2.5 PURPOSE

This product is a 100% transparent finish used to seal concrete floors and various other surfaces and resists abrasion, acids, alkali, hot and cold water, salt water, oils and alcohol's, ink, black rubber marks and gasoline. EPOX-O-LON is for interior use only.

PART 3 EXECUTION

3.0 PREPARATION

- A. Concrete floors and bases shall be in proper condition to receive epoxy flooring.
 - a. Concrete shall be clean and flat with proper texture to receive finish.
 - b. Protect surfaces to receive epoxy coating.
- B. Concrete should be cured for a minimum of 30 days prior to application.
- C. Surface must be clean and dry prior to application.
- D. Previously coated surfaces must be cleaned using a stiff wire brush to remove all loose coating. All oil, wax or grease should be cleaned from the surface and all residue removed as well.
- E. Concrete floors may need to be etched prior to application. (Unclean surfaces can affect drying and adhesion). Do not use Muriatic Acid to etch surfaces. Shot blasting may be required with a system such as Blastec.
- C. Commencement of work shall constitute acceptance of surfaces.

3.1 MIXING

- A. Contractor shall mix silica sand or Aluminum Oxide with the product in proportion to Owner approved sample.

3.2 INSTALLATION

- A. Epoxy floors and bases shall be installed in strict compliance with manufacturer's recommendations. Surface areas are to be troweled with power trowel in areas that will permit. Hand troweling is to be kept to a minimum.
 - a. Form concrete and wood bases to clean, uniform lines and according to details on drawings, See Details No. 14 and 15, Sheet A-8.
 - b. Where epoxy floors meet other floors, form a transition with epoxy to be flush with other material. See Detail 16/A-8.
 - 1. Form transition with epoxy flooring to a straight uniform line.
- B. Apply using a lambswool applicator or a clean soft bristled brush. Apply in thin even coats and avoid puddling. (Rollers are not recommended as they introduce air and cause bubbling to the surface.
- C. Apply a minimum of two coats. When applying multiple coats #2 steel wool should be used between coats. The surface being coated should have an even glossy appearance following the final application. If the surface is still experiencing areas of dull sheen another coat will be needed to complete the process of sealing.

SECTION 09670 – SELF-LEVELING FLAKE FLOORING**PART 1 GENERAL****1.0 SUMMARY**

- A. Work described in this section includes surface preparation and installation of Silikal reactive resin industrial floor system.
- B. See drawings for locations and quantities.

1.1 RELATED WORK

- A. Section 04200 Masonry
- B. Section 09250 Gypsum Walls
- C. Section 09920 Interior Painting

1.2 DESCRIPTION

- A. The Silikal 62 SLF is a 4-6mm (3/16"-1/4") thick troweled surfacing composite of Silikal 100% reactive binder resin and Silikal Fillers with specified Silikal primer and topcoat.
- B. The Silikal coating system shall cure completely and be available to normal operations in no more than 90 minutes at Temperatures as low as 0 °C. after application of the final coat.
- C. The finished Silikal floor coating system shall be uniform in color combinations, texture, and appearance. All edges that terminate at walls, floor discontinuities, and other embedded items shall be sharp, uniform, and cosmetically acceptable with no thick or ragged edges. The Contractor shall work out an acceptable masking technique to ensure the acceptable finish of all edges.
- D. See Paragraph 3.04 and/or 3.07 for number and thicknesses of each coat/layer in each system.
- E. All resins must be manufactured and tested under an ISO 9001 registered quality system and ISO 14001 ecology management system.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Acceptable manufacturer: Silikal GmbH, Germany.
- B. Applicator Qualifications:
 - 1. Pre-qualification requirements: Only approved applicators, licensed by Silikal shall be considered for qualification. In no case will Silikal permit the application of any of its materials by untrained, non-approved Contractor or personnel.
 - 2. Each approved applicator shall have been qualified by the Manufacturer as knowledgeable in all phases of surface preparation.
 - 3. Each approved applicator must have three (3) years experience of installing resinous flooring systems and submit a list of five projects/references as a prequalification requirement. At least one of the five projects/ references must be of equal size, quantity, and magnitude to this project as a prequalification requirement. Owner has the option to personally inspect the projects/references to accept or reject any of the Contractors prior to bid time as a prequalification requirement.
- C. Subcontractor Qualifications:
 - 1. The only approved and specified subcontractors for this resurfacing work shall be for shot-blast cleaning of the concrete substrate.
- D. Acceptance Sample:
 - 1. Representative sample of the specified flooring system shall be submitted to the Owner prior to the bidding phase of the project. All bidders shall inspect the "acceptance sample" before submitting their bids.
 - 2. The installed flooring system shall be similar to the acceptance sample in thicknesses of respective film-layers, color, texture, overall appearance and finish.
- E. Bond Testing:
 - 1. Surface preparation efforts shall be evaluated by conducting Bond Tests at the site prior to application of the flooring system(s).
 - 2. See paragraph 3.03 - B or consult with Material Manufacturer for specific procedure.
- F. Pre-Job Meeting
 - 1. Owner requires a Pre-Job Meeting with representatives of Owner, Contractor/Applicator, and Material Manufacturer in attendance. The agenda shall include a review and clarification of this specification,

application procedures, quality control, inspection and acceptance criteria, and production schedules. Applicator is not authorized to proceed until this meeting is held or waived by Owner.

1.4 REFERENCE STANDARDS

- A. ACI 308 - Standard Practice for Curing Concrete
- B. ACI 302.1R-80 - Guide for Concrete Floor and Slab Construction

1.5 SUBMITTALS

- A. Acceptance Sample: As required by owner, one foot square (4"X4") sample of the specified acrylic flooring system applied to hardboard or similar backing for rigidity and ease of handling.
- B. Manufacturer's Literature: Descriptive data and specific recommendations for surface preparation, mixing, and application of materials.
- C. Manufacturer's Material Safety Data Sheets (MSDS) for each respective product to be used.
- D. Cleaning and Maintenance

1.6 DELIVERY, STORAGE AND HANDLING

- A. All material shall be delivered in original Manufacturer's sealed containers with all pertinent labels intact and legible.
- B. Store materials in dry protected area between 25° and 80° Fahrenheit. Keep out of direct sunlight. Protect from open flame; keep all containers grounded.
- C. Follow all Manufacturer's specific label instructions and prudent safety practices for storage and handling.

1.7 PROJECT CONDITIONS

- A. Material, air, and surface temperatures shall be in the range of 32° to 85° Fahrenheit during application and cure, unless a special formulation is being used and Manufacturer has been consulted.
- B. Relative humidity in the specific location of the application shall be less than 85 percent and the surface temperature shall be at least 5 degrees above the dew point.
- C. Conditions required of new concrete to be coated.
 - 1. Concrete shall be moisture cured for a minimum of 7 days at 70° F. The concrete must be fully cured for a minimum of 28 days prior to application of the coating system pending moisture testing.
 - 2. Surface contaminants such as curing agents, membranes, or other bond breakers should not be used.
 - 3. Concrete shall have a "rubbed" finish; float or darby finish the concrete (a hard steel trowel is neither necessary nor desirable).
 - 4. Drains should be set to the concrete grade rather than raised to the finished grade of the topping.
- D. Concrete shall have a moisture emission rate of no more than 5 lbs. per 1000 sq. ft. per 24 hour period as determined by proper Calcium Chloride Testing. Concrete R/H must be 85% or less as measured by protimeter. Readings greater than 5 by the Calcium Chloride method or 85% by protimeter, may require a preliminary treatment with Silikal RE40.
- E. Foodstuffs are the responsibility of the Owner and shall have been removed from the area of application by the Owner or his representatives.
- F. Vapor barriers and/or suitable means shall have been installed beneath grade slabs to prevent vapor transmission. Consult technical dept.

1.8 WARRANTY

- A. Material Warranty, as provided by Silikal, shall cover a period of five years from date of application.

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. Silikal GmbH, Germany

2.1 MATERIALS

- A. Silikal 62 SLF Self Leveling Flake Flooring
1. Moisture Vapor Treatment (if required)
Silikal RE40
 2. Saturating Primer/Silikal Coat:
Silikal R41 with Additive I
 3. Patching/Sloping (if required)
Silikal R17 Polymer Concrete
 4. Coving (if required):
Silikal HK20 with #10-#12 mesh dry silica sand.
 5. Topping:
Silikal R61 SL, consisting of Silikal R61 resin and Silikal Filler
 6. Topcoat(s):
Silikal 71R Colorless Silikal Topcoat Resin.
 7. Silikal Flakes for broadcasting: Color #4 - 60% Marine Black, Color #3 - 30% Steel Gray,
Color # 24 - 5% Royal Blue and Color #5 - 5% Eggshell White.
 8. Aluminium Oxide: No. 20 bead broadcast 2lb/100sf between two 71R topcoats.

2.2 PRODUCT PERFORMANCE CRITERIA

- A. Silikal RE40
1. Percentage Reactive Resin 100%
 - Percentage Solids 100%
 2. Water Pressure Resistance (3 days at 72 psi) Passed
 3. Resistance to Diffusion Against H₂O 0.3g/m² • day
 4. Tensile Bond Strength.....475 psi
- B. Silikal R41 With Additive I
1. Percentage Reactive Resin 100%
 - Percentage Solids 100%
 2. Water Absorption, Wt. % (ASTM D570): less than 0.6
 3. Tensile Strength, psi (ASTM D638).....3,550 psi.
 4. Tensile Modulus, psi X 10 to the 5th (ASTM D638): 2.1
 5. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696): 0.000035
 6. Electrical Resistivity (ASTM D257):
Volume Resistance, ohm-cm: 10¹⁵
Surface Resistance, ohm:.....10¹²
 7. Water Vapor Transmission (DIN 53122), g/cm-hr-mm Hg X 10-9: 1.4
- C. Silikal R17 Polymer Concrete
1. Percentage of reactive resin 100%
 2. Water Absorption, Wt. % (ASTM D570): 0.02
 3. Tensile Strength, psi (ASTM D638).....1,200 psi.
 4. Tensile Modulus, psi X 10 to the 5th (ASTM D638):.....1.2
 5. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696) psi x10-6: 18
 6. Compressive Strength, psi (ASTM C39).....9,200 psi.
(ASTM C109).....11,000 psi.
- D. Silikal R61 SL Topping
1. Percentage of reactive resin: 100%
 - Percentage of solids: 100%
 2. Water Absorption, Wt. % (ASTM D570): 0.04
 3. Compressive Strength, psi (ASTM C109): 6,000-8,000 psi.
(ASTM D695): 6,000 psi.
 4. Tensile Strength, psi (ASTM D638): 3,625 psi.
 5. Tensile Modulus, psi (ASTM D638):.....720,000 psi.
 6. Flexural Strength, psi (ASTM D790): 3,500 psi.
 7. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696): 0.000019
 8. Electrical Resistivity, (ASTM D257) Volume Resistance, ohm-cm: 10¹⁴
 9. Chemical Resistance, ASTM D543:
Effect of weak acids: none
Effect of strong acids:.....slight
Effect of alkalis:.....none
Effect of salt solutions:.....none

	Effect of oil, grease:.....	none
	Effect of sunlight (UV radiation):.....	none
E.	Silikal 71R Colorless Topcoat Resin	
1.	Percentage Reactive Resin:.....	100%
	Percentage Solids:.....	100%
2.	Water Absorption, Wt. % (ASTM D570):	0.5
3.	Tensile Strength, psi (ASTM D638):.....	3,555 psi.
4.	Tensile Modulus, psi (ASTM D638):.....	210,000 psi.
5.	Coefficient of Thermal Expansion (ASTM D696) in./in./deg. F:.....	0.000035
6.	Electrical Resistivity (ASTM D257):	
	Volume Resistance, ohm-cm:	10 ¹⁵
	Surface Resistance, ohm:.....	10 ¹²
7.	Water Vapor Transmission (DIN 53122) g/cm-hr-mm Hg X 10 ⁻⁹ :.....	1.43
8.	Chemical Resistance, ASTM D543:	
	Effect of weak acids:.....	none
	Effect of strong acids:	slight
	Effect of alkalis:.....	none
	Effect of salt solutions:.....	none
	Effect of oil, grease:	none
	Effect of sunlight (UV radiation):	none

2.3 PRODUCT INSTALLATION AND APPLICATION CRITERIA

- A. All Silikal Material Systems Excepting Moisture Vapor Treatment:
1. Pot Life at 68° F.:.....10-15 minutes
 2. Cure Time at 68° F.:.....60 minutes
 3. Recoat Time at 68° F.:.....60-90 minutes

2.4 MIXES

- A. Follow manufacturer's prescribed procedures and recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine all surfaces to be coated with Silikal material systems and report to the Owner any conditions that will adversely affect the appearance or performance of these coating systems and that cannot be put into acceptable condition by the preparatory work specified in Paragraph 3.03.
- B. Do not proceed with application until the surface is acceptable or authorization to proceed is given by the Manufacturer's representative.

3.1 GENERAL

- A. Material storage area must be selected and approved by Applicator and Owner or his representative.
- B. If existing ventilation is inadequate, Applicator will provide sufficient ventilation to allow complete air exchange every five (5) minutes.
- C. Contractor shall dispose of construction waste off site.
- E. Applicator will protect adjacent surfaces not to be coated with masking and/or covers. Owner's equipment shall be protected from dust, cleaning solutions, and flooring materials.

3.1 PREPARATION

- A. Surface Preparation - General
1. Concrete substrate must be clean and dry. Dislodge dirt, mortar spatter, paint overspray, and other dry surface accumulations and contamination by scraping, brushing, sweeping, vacuuming, and/or compressed air blowdown.
 2. New concrete: Ensure manufacturer's recommendations are followed precisely.
 3. Surfaces that are heavily contaminated shall be cleaned with the appropriate degreaser, detergent, or other appropriate cleaner/surfactant followed by thoroughly rinsing with fresh water to remove the

accumulation prior to mechanical cleaning efforts. Mechanical cleaning will not remove such deposits, but only drive them deeper.

4. Concrete shall have a moisture emission rate of no more than 5 lbs. per 1000 sq. ft. per 24 hour period as determined by proper Calcium Chloride Testing and no more than 85% R/H as measured by Protimeter

B. Bond Testing

1. The applicator shall evaluate all surface preparation by conducting bond tests at strategic locations.
2. Mix six (6) ounces of the primer to be used in the application with 5% by volume Silikal Powder Hardener. Add #10-#12 mesh, dry quartz sand until an easily trowelable mixture is obtained. Apply palm-sized patties 1/8" to 1/4" thick.
3. After one (1) hour at (68° F.), patties must be cured tack-free and cooled to ambient temperature of concrete. Remove patties with hammer and chisel and examine fracture/de-lamination plane. Concrete with fractured aggregate must be attached to the entire underside of the patty.
4. If only laitance or a small amount of concrete is attached or if interface between patty and substrate is tacky, further substrate preparation is required.
5. If further surface preparation is required, bond tests shall be conducted again when this has been completed.
6. If no amount or kind of surface preparation produces satisfactory bond tests, the applicator shall report that to the Owner, Engineer, and Manufacturer.

C. Mechanical Surface Preparation and Cleaning

1. All accessible concrete floor surfaces shall be mechanically blast cleaned using a mobile steel shot, dust recycling machine such as BLASTRAC®, or approved equivalent. All surface and embedded accumulations of paint, toppings, hardened concrete layers, laitance, power trowel finishes, and other similar surface characteristics shall be completely removed leaving a bare concrete surface having a profile similar to 40 grit sandpaper and exposing the upper fascia of concrete aggregate.
2. Floor areas inaccessible to the mobile blast cleaning machines shall be mechanically abraded to the same degree of cleanliness, soundness, and profile using vertical disc scarifiers, starwheel scarifiers, needle guns, scabblers, or other suitably effective equipment.
3. After blasting, traces or accumulations of spent abrasive, laitance, removed toppings, and other debris shall be removed with brush or vacuum.
4. Conduct Bond Tests to check adequacy of surface preparation. See Paragraph 3.03 - B (Bond Testing).
5. Application of the respective specified material system(s) must be completed before any water or other contamination of the surface occurs.

3.2 INSTALLATION

A. Application of Silikal 62 SLF flooring system consists of:

1. applying moisture vapor treatment (if required)
 2. applying the primer,
 3. applying coving (if required),
 4. performing patching and sloping with polymer concrete (if required),
 5. re-priming polymer concrete areas
 6. applying the topping, broadcasting the Silikal Flakes.
 7. applying the topcoat(s),
- Time for curing (45 - 60 minutes) shall be allowed between each coat.

Thicknesses are specified below and/or in Paragraph 3.07.

- B.** Open only the containers of component materials to be use in each specific application as needed. Refer to Manufacturer's data sheets for pot-life/temperature relationship to determine size of batches to mix and mix ratios for each respective coat of the system.
- C.** Measure, add, and mix the Silikal BP-Powder Hardener into the respective resin components in the proportions recommended by the Material Manufacturer. Pot life is short, so mix only as much material at a time as can be easily and efficiently applied.

3.3 MOISTURE VAPOR TREATMENT (IF REQUIRED)

- A.** Mix moisture vapor treatment products as recommended by manufacturer.
- B.** Pour out all resin onto the concrete surface and spread it with a squeegee. After a short operating time (appr. 10 minutes) the excess must be removed with the squeegee. The remaining resin can be rolled out with a lint free resin proof roller. Resin films as well as the building of puddles have to be avoided!

The waiting time between the coats depends on the absorbency of the substrate and is normally between one and three hours. Before applying the second coat if required, the impregnation of the first coat into the substrate should be evident.

- C. If required, repeat the above process. During application of the treatment take care that there is no film building at the surface. The surface texture has to be maintained after every step.

3.3 PRIME COAT

- A. Mix primer components according to manufacturer's instructions.
- B. Pour the mixture batches onto the floor surface and use a 9" or 18" wide, 1/2" - 3/4" thick-napped, solvent resistant paint roller to roll out the material at a rate of 100 sq. ft./ gal. to form a uniform, continuous film, ensuring that all crevices, cracks, other surface discontinuities have been saturated and coated. Use a paint brush to reach areas inaccessible to the roller. Work quickly and deliberately; the pot life is short (10 - 15 minutes). Do not leave any "puddles"; roll out any such accumulations.
- C. Allow the primer coat to cure.
- D. If any of the concrete has absorbed all of the primer or if the concrete still has a dry look, reprime these areas before applying the next layer.

3.3 COVING (IF REQUIRED)

- A. If concrete walls are to be painted prior to installation of cove base, the bottom portion of the walls shall remain uncoated to the height of the cove base to insure a proper bond to the concrete wall.
- B. If walls are constructed of a non-compatible material or if a coating exists, a backer board of 1/2" cement board cut to the desired height of the cove base needs to be installed. The top of the backer board should be cut at a 45° angle to create a "beveled" edge.
- C. If a backer board needs to be installed it shall be fastened using a high grade construction adhesive as well as counter sunk screws or concrete masonry anchors.
 - 2. System Description
- A. Cove base shall be installed according to manufacturer's recommendations and shall be:
 - 1. Application area requires prime coat according to 3.04.02
 - 2. Trowel-On Cove Base consisting of a trowel applied radius/base mix with a termination strip installed at the top of the base.
- B. Cove base will receive a broadcast and top coat consistent with flooring system.

3.4 PATCHING / SLOPING (IF REQUIRED)

- A. Mix polymer concrete components as recommended by the Material Manufacturer.
- B. Use mixture to repair any damaged concrete, or to slope any areas as needed.
- C. Once cured, material must be re-primed before next layer is applied.

3.5 TOPPING

- A. Size the batches, and mix according to Manufacturer's instructions. The entire batch should be poured and spread at once, i.e., do not let material set in pail.
- B. Spread the topping material with a gauge rake set to a depth of 3/16". Lightly trowel to a uniform thickness of 3/16" as necessary.
- C. If necessary, roll with a porcupine roller to release trapped air.
- D. Broadcast Silikal flakes into the fresh material before it begins to cure. Broadcast by hand, or use a backpack type blower or sand blast pot to achieve an even broadcast. The flakes must 'rain' down and not be thrown into the wet base coat.
- E. Allow the topping to cure.
- F. Remove excess flakes by sweeping, "blow-down", and/or vacuuming.

3.6 TOP COAT

- A. Apply with clean rollers at a rate of 100 sq. ft./gal. in the same way as the Silikal Primer was applied as described in Paragraph 3.04.02.
- B. Broadcast aluminium oxide, or other suitable material into first wet topcoat resin at 2lbs./100sf.
- C. Allow topcoat to cure.

3.7 SECOND TOP COAT

- A. Apply with clean rollers at a rate of 100 - 125 sq. ft./gal. in the same way as the Silikal Primer was applied as described in Paragraph 3.04.02.
- B. Allow topcoat to cure.

3.8 FIELD QUALITY CONTROL

- A. Applicator shall request acceptance of surface preparation from the manufacturer's representative before application of the prime/seal coat.
- B. Applicator shall request acceptance of the prime coat from the manufacturer's representative before application of subsequent specified materials.

3.9 CLEANING

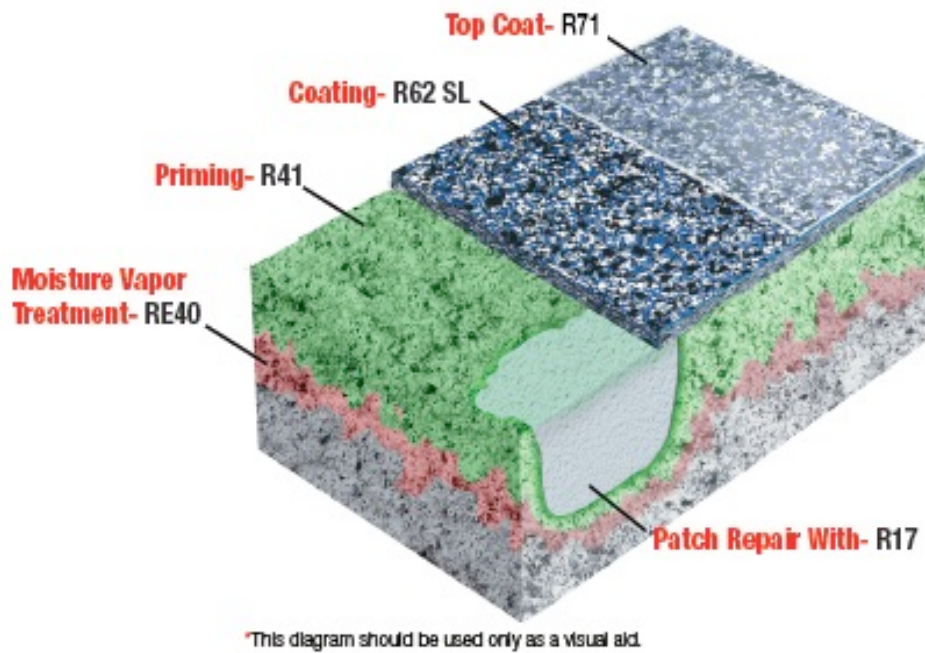
- A. Applicator shall remove any material spatters and other material that is not where it should be. Remove masking and covers taking care not to contaminate surrounding area.
- B. Applicator shall repair any damage that should arise from either the application or clean-up effort.

3.10 JOINT SEALANT

- A. Upon completion of floor system, apply Sika Flex 1A NS polyurethane sealant. Color: Black at base edge of pit / stair steel and floor. Apply on a 45 degree angle to prevent ponding.
- B. Utilize the same product above for concrete control joints. Contractor shall cut in control joints to match joints in concrete floor and follow with application of joint sealant.

3.11 COATING SCHEDULE

- A. Moisture vapor treatment shall be Silikal RE40 application rate shall be approximately 220 sq. ft. per gallon (approx. 7 mils)
- B. Primer shall be Silikal R41 with Additive I Application rate shall be approx. 100 sq.ft. per gallon (approx. 16 mils).
- C. Patching/Sloping material shall be R17
- D. Flexible membrane shall be Silikal RV368 applied with a gauge rake set at 1/16" for a rate of 40 sq. ft. per batch.
- E. Coving shall be Silikal HK 20 per manufacturer's recommendations.
- F. Body coat shall be Silikal R62 SL, applied with a gauge rake set at 1/8" for a rate of 40 sq. ft. per batch. flakes to be broadcast into the uncured topping. Broadcast the flakes at the rate of 0.15 – 0.25 pounds per sq. ft.
- G. Clear topcoat shall be Silikal 71R; apply at the rate of 100 sq. ft. per gallon for the first coat and 100-120 sq. ft. per gallon for the second application. Broadcast with Aluminum Oxide.



Refer to the manufacturer's data sheets for the relevant Silikal resins for the guideline recipes, material consumption, hardener quantities, etc.

SECTION 09671 – SELF-LEVELING QUARTZ FLOORING**PART 1 GENERAL****1.0 SUMMARY**

- A. Work described in this section includes surface preparation and installation of Silikal reactive resin industrial floor system.
- B. See drawings for locations and quantities.

1.1 RELATED WORK

- A. Section 04200 Masonry
- B. Section 09250 Gypsum Walls
- C. Section 09920 Interior Painting

1.2 DESCRIPTION

- A. The Silikal 61 CQ is a 4-6mm (3/16"-1/4") thick troweled surfacing composite of Silikal 100% reactive binder resin and Silikal colored quartz aggregate with specified Silikal primer and topcoat.
- B. The Silikal coating system shall cure completely and be available to normal operations in no more than 90 minutes at temperatures as low as 0 °C. after application of the final coat.
- C. The finished Silikal floor coating system shall be uniform in color combinations, texture, and appearance. All edges that terminate at walls, floor discontinuities, and other embedded items shall be sharp, uniform, and cosmetically acceptable with no thick or ragged edges. The Contractor shall work out an acceptable masking technique to ensure the acceptable finish of all edges.
- D. See Paragraph 3.04 and/or 3.07 for number and thicknesses of each coat/layer in each system.
- E. All resins must be manufactured and tested under an ISO 9001 registered quality system and ISO 14001 ecology management system.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Acceptable manufacturer: Silikal GmbH, Germany
- B. Applicator Qualifications:
 - 1. Pre-qualification requirements: Only approved applicators, licensed by Silikal shall be considered for qualification. In no case will Silikal permit the application of any of its materials by untrained, non-approved Contractor or personnel.
 - 2. Each approved applicator shall have been qualified by the Manufacturer as knowledgeable in all phases of surface preparation.
 - 3. Each approved applicator must have three (3) years experience of installing resinous flooring systems and submit a list of five projects/references as a prequalification requirement. At least one of the five projects/ references must be of equal size, quantity, and magnitude to this project as a prequalification requirement. Owner has the option to personally inspect the projects/references to accept or reject any of the Contractors prior to bid time as a prequalification requirement.
- C. Subcontractor Qualifications:
 - 1. The only approved and specified subcontractors for this resurfacing work shall be for shot-blast cleaning of the concrete substrate.
- D. Acceptance Sample:
 - 1. Representative sample of the specified flooring system shall be submitted to the Owner prior to the bidding phase of the project. All bidders shall inspect the "acceptance sample" before submitting their bids.
 - 2. The installed flooring system shall be similar to the acceptance sample in thicknesses of respective film-layers, color, texture, overall appearance and finish.
- E. Bond Testing:
 - 1. Surface preparation efforts shall be evaluated by conducting Bond Tests at the site prior to application of the flooring system(s).

2. See paragraph 3.03 - B or consult with Material Manufacturer for specific procedure.
- F. Pre-Job Meeting
 1. Owner requires a Pre-Job Meeting with representatives of Owner, Contractor/Applicator, and Material Manufacturer in attendance. The agenda shall include a review and clarification of this specification, application procedures, quality control, inspection and acceptance criteria, and production schedules. Applicator is not authorized to proceed until this meeting is held or waived by Owner.

1.4 REFERENCE STANDARDS

- A. ACI 308 - Standard Practice for Curing Concrete
- B. ACI 302.1R-80 - Guide for Concrete Floor and Slab Construction
- C. United States Department of Agriculture (USDA) and (Food and Drug Administration (FDA) authorization) for incidental contact with foodstuffs.

1.5 SUBMITTALS

- A. Acceptance Sample: As required by owner, one foot square (4"X4") sample of the specified acrylic flooring system applied to hardboard or similar backing for rigidity and ease of handling.
- B. Manufacturer's Literature: Descriptive data and specific recommendations for surface preparation, mixing, and application of materials.
- C. Manufacturer's Material Safety Data Sheets (MSDS) for each respective product to be used.
- D. Cleaning and Maintenance

1.6 DELIVERY, STORAGE, AND HANDLING

- A. All material shall be delivered in original Manufacturer's sealed containers with all pertinent labels intact and legible.
- B. Store materials in dry protected area between 25° and 80° Fahrenheit. Keep out of direct sunlight. Protect from open flame; keep all containers grounded.
- C. Follow all Manufacturer's specific label instructions and prudent safety practices for storage and handling.

1.7 PROJECT CONDITIONS

- A. Material, air, and surface temperatures shall be in the range of 32° to 85° Fahrenheit during application and cure, unless a special formulation is being used and Manufacturer has been consulted.
- B. Relative humidity in the specific location of the application shall be less than 85 percent and the surface temperature shall be at least 5 degrees above the dew point.
- C. Conditions required of new concrete to be coated.
 1. Concrete shall be moisture cured for a minimum of 7 days at 70° F. The concrete must be fully cured for a minimum of 28 days prior to application of the coating system pending moisture testing.
 2. Surface contaminants such as curing agents, membranes, or other bond breakers should not be used.
 3. Concrete shall have a "rubbed" finish; float or darby finish the concrete (a hard steel trowel is neither necessary nor desirable).
 4. Drains should be set to the concrete grade rather than raised to the finished grade of the topping.
- D. Concrete shall have a moisture emission rate of no more than 5 lbs. per 1000 sq. ft. per 24 hour period as determined by proper Calcium Chloride Testing. Concrete R/H must be 85% or less as measured by protimeter. Readings greater than 5 by the Calcium Chloride method or 85% by protimeter, may require a preliminary treatment with Silikal RE40.
- E. Vapor barriers and/or suitable means shall have been installed beneath grade slabs to prevent vapor transmission. Consult technical dept.

1.8 WARRANTY

- A. Material Warranty, as provided by Silikal, shall cover a period of five years from date of application.

PART 2 PRODUCTS

2.0 MANUFACTURERS

A. Silikal GmbH, Germany

2.1 MATERIALS

- A. Silikal 61 CQ Decorative Quartz Flooring
1. Moisture Vapor Treatment (if required)
Silikal RE40
 2. Saturating Primer/Silikal Coat:
Silikal R41 with Additive I
 3. Patching/Sloping (if required)
Silikal R17 Polymer Concrete
 4. Coving (if required):
Silikal HK20 with Silikal filler CQ
 5. Topping:
Silikal R61 Quartz, consisting of Silikal R61 resin and Silikal Filler
 6. Topcoat(s):
Silikal R81 Colorless Silikal Topcoat Resin.
 7. Silikal CQ for broadcasting: 70% Black, 10% Blue, 10% Grey, 10% White

2.2 PRODUCT PERFORMANCE CRITERIA

- A. Silikal RE40
1. Percentage Reactive Resin 100%
 - Percentage Solids 100%
 2. Water Pressure Resistance (3 days at 72 psi) Passed
 3. Resistance to Diffusion Against H₂O 0.3g/m² • day
 4. Tensile Bond Strength.....475 psi
- B. Silikal R41 With Additive I
1. Percentage Reactive Resin 100%
 - Percentage Solids 100%
 2. Water Absorption, Wt. % (ASTM D570): less than 0.6
 3. Tensile Strength, psi (ASTM D638).....3,550 psi.
 4. Tensile Modulus, psi X 10 to the 5th (ASTM D638): 2.1
 5. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696): 0.000035
 6. Electrical Resistivity (ASTM D257):
Volume Resistance, ohm-cm: 10¹⁵
Surface Resistance, ohm:.....10¹²
 7. Water Vapor Transmission (DIN 53122), g/cm-hr-mm Hg X 10-9: 1.4
- C. Silikal R17 Polymer Concrete
1. Percentage of reactive resin 100%
 2. Water Absorption, Wt. % (ASTM D570): 0.02
 3. Tensile Strength, psi (ASTM D638).....4,000 psi.
 4. Tensile Modulus, psi X 10 to the 5th (ASTM D638):.....1.2
 5. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696) psi x10-6:.....18
 6. Compressive Strength, psi (ASTM C39).....9,200 psi.
(ASTM C109).....11,000 psi.
- D. Silikal R61CQ Topping
1. Percentage of reactive resin: 100%
 - Percentage of solids: 100%
 2. Water Absorption, Wt. % (ASTM D570): 0.04
 3. Compressive Strength, psi (ASTM C109): 6,000-8,000 psi.
(ASTM D695): 6,000 psi.
 4. Tensile Strength, psi (ASTM D638): 3,625 psi.
 5. Tensile Modulus, psi (ASTM D638):.....720,000 psi.
 6. Flexural Strength, psi (ASTM D790): 3,500 psi.
 7. Coefficient of Thermal Expansion, in./in./deg. F (ASTM D696): 0.000019
 8. Electrical Resistivity, (ASTM D257) Volume Resistance, ohm-cm: 10¹⁴
 9. Chemical Resistance, ASTM D543:

- Effect of weak acids: none
 Effect of strong acids:.....slight
 Effect of alkalis:.....none
 Effect of salt solutions:.....none
 Effect of oil, grease:.....none
 Effect of sunlight (UV radiation):.....none
- E. Silikal R81 Colorless Topcoat Resin
1. Percentage Reactive Resin:.....100%
 Percentage Solids:.....100%
 2. Water Absorption, Wt. % (ASTM D570): 0.5
 3. Tensile Strength, psi (ASTM D638):.....3,555 psi.
 4. Tensile Modulus, psi (ASTM D638):.....210,000 psi.
 5. Coefficient of Thermal Expansion (ASTM D696) in./in./deg. F:.....0.000035
 6. Electrical Resistivity (ASTM D257):
 Volume Resistance, ohm-cm: 10¹⁵
 Surface Resistance, ohm:.....10¹²
 7. Water Vapor Transmission (DIN 53122) g/cm-hr-mm Hg X 10⁻⁹:.....1.43
 8. Chemical Resistance, ASTM D543:
 Effect of weak acids:.....none
 Effect of strong acids: slight
 Effect of alkalis:.....none
 Effect of salt solutions:.....none
 Effect of oil, grease: none
 Effect of sunlight (UV radiation): none

2.02.02 Product Installation & Application Criteria

- A. All Silikal Material Systems Excepting Moisture Vapor Treatment:
1. Pot Life at 68° F.:.....10-15 minutes
 2. Cure Time at 68° F.:.....60 minutes
 3. Recoat Time at 68° F.:.....60-90 minutes

2.3 MIXES

- A. Follow manufacturer's prescribed procedures and recommendations. Color Mix: 70% black, 10% blue, 10% grey, 10% white.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine all surfaces to be coated with Silikal material systems and report to the Owner any conditions that will adversely affect the appearance or performance of these coating systems and that cannot be put into acceptable condition by the preparatory work specified in Paragraph 3.03.
- B. Do not proceed with application until the surface is acceptable or authorization to proceed is given by the Manufacturer's representative.

3.1 GENERAL

- A. Material storage area must be selected and approved by Applicator and Owner or his representative.
- B. If existing ventilation is inadequate, Applicator will provide sufficient ventilation to allow complete air exchange every five (5) minutes.
- C. Contractor shall dispose of construction waste off site.
- D. Applicator will protect adjacent surfaces not to be coated with masking and/or covers. Owner's equipment shall be protected from dust, cleaning solutions, and flooring materials.

3.1 PREPARATION

- A. Surface Preparation - General

1. Concrete substrate must be clean and dry. Dislodge dirt, mortar spatter, paint overspray, and other dry surface accumulations and contamination by scraping, brushing, sweeping, vacuuming, and/or compressed air blowdown.
 2. New concrete: Ensure manufacturer's recommendations are followed precisely.
 3. Surfaces that are heavily contaminated shall be cleaned with the appropriate degreaser, detergent, or other appropriate cleaner/surfactant followed by thoroughly rinsing with fresh water to remove the accumulation prior to mechanical cleaning efforts. Mechanical cleaning will not remove such deposits, but only drive them deeper.
 4. Concrete shall have a moisture emission rate of no more than 5 lbs. per 1000 sq. ft. per 24 hour period as determined by proper Calcium Chloride Testing and no more than 85% R/H as measured by Protimeter
- B. Bond Testing
1. The applicator shall evaluate all surface preparation by conducting bond tests at strategic locations.
 2. Mix six (6) ounces of the primer to be used in the application with 5% by volume Silikal Powder Hardener. Add #10-#12 mesh, dry quartz sand until an easily trowelable mixture is obtained. Apply palm-sized patties 1/8" to 1/4" thick.
 3. After one (1) hour at (68° F.), patties must be cured tack-free and cooled to ambient temperature of concrete. Remove patties with hammer and chisel and examine fracture/de-lamination plane. Concrete with fractured aggregate must be attached to the entire underside of the patty.
 4. If only laitance or a small amount of concrete is attached or if interface between patty and substrate is tacky, further substrate preparation is required.
 5. If further surface preparation is required, bond tests shall be conducted again when this has been completed.
 6. If no amount or kind of surface preparation produces satisfactory bond tests, the applicator shall report that to the Owner, Engineer, and Manufacturer.
- C. Mechanical Surface Preparation and Cleaning
1. All accessible concrete floor surfaces shall be mechanically blast cleaned using a mobile steel shot, dust recycling machine such as BLASTRAC®, or approved equivalent. All surface and embedded accumulations of paint, toppings, hardened concrete layers, laitance, power trowel finishes, and other similar surface characteristics shall be completely removed leaving a bare concrete surface having a profile similar to 40 grit sandpaper and exposing the upper fascia of concrete aggregate.
 2. Floor areas inaccessible to the mobile blast cleaning machines shall be mechanically abraded to the same degree of cleanliness, soundness, and profile using vertical disc scarifiers, starwheel scarifiers, needle guns, scabblers, or other suitably effective equipment.
 3. After blasting, traces or accumulations of spent abrasive, laitance, removed toppings, and other debris shall be removed with brush or vacuum.
 4. Conduct Bond Tests to check adequacy of surface preparation. See Paragraph 3.03 - B (Bond Testing).
 5. Application of the respective specified material system(s) must be completed before any water or other contamination of the surface occurs.

3.3 INSTALLATION

- A. Application of Silikal 61 CQ flooring system consists of:
1. applying moisture vapor treatment (if required)
 2. applying the primer,
 3. applying coving (if required),
 4. performing patching and sloping with polymer concrete (if required),
 5. re-priming polymer concrete areas
 6. applying the topping, broadcasting the quartz
 7. applying the topcoat(s),
- Time for curing (45 - 60 minutes) shall be allowed between each coat.
Thicknesses are specified below and/or in Paragraph 3.07.
- B. Open only the containers of component materials to be use in each specific application as needed. Refer to Manufacturer's data sheets for pot-life/temperature relationship to determine size of batches to mix and mix ratios for each respective coat of the system.
- C. Measure, add, and mix the Silikal BP-Powder Hardener into the respective resin components in the proportions recommended by the Material Manufacturer. Pot life is short, so mix only as much material at a time as can be easily and efficiently applied.

3.4 MOISTURE VAPOR TREATMENT (IF REQUIRED)

- A. Mix moisture vapor treatment products as recommended by manufacturer.
- B. Pour out all resin onto the concrete surface and spread it with a squeegee. After a short operating time (appr. 10 minutes) the excess must be removed with the squeegee. The remaining resin can be rolled out with a lint free resin proof roller. Resin films as well as the building of puddles have to be avoided! The waiting time between the coats depends on the absorbency of the substrate and is normally between one and three hours. Before applying the second coat, the impregnation of the first coat into the substrate should be evident.
- C. If required, repeat the above process. During application of the treatment take care that there is no film building at the surface. The surface texture has to be maintained after every step.

3.5 PRIME COAT

- A. Mix primer components according to manufacturers instructions.
- B. Pour the mixture batches onto the floor surface and use a 9" or 18" wide, 1/2" - 3/4" thick-napped, solvent resistant paint roller to roll out the material at a rate of 100 sq. ft./ gal. to form a uniform, continuous film, ensuring that all crevices, cracks, other surface discontinuities have been saturated and coated. Use a paint brush to reach areas inaccessible to the roller. Work quickly and deliberately; the pot life is short (10 - 15 minutes). Do not leave any "puddles"; roll out any such accumulations.
- C. Allow the primer coat to cure.
- D. If any of the concrete has absorbed all of the primer or if the concrete still has a dry look, re-prime these areas before applying the next layer.

3.6 COVING (IF REQUIRED)

- 1. Surface Preparation
 - A. If concrete walls are to be painted prior to installation of cove base, the bottom portion of the walls shall remain uncoated to the height of the cove base to insure a proper bond to the concrete wall.
 - B. If walls are constructed of a non-compatible material or if a coating exists, a backer board of 1/2" cement board cut to the desired height of the cove base needs to be installed. The top of the backer board should be cut at a 45° angle to create a "beveled" edge.
 - C. If a backer board needs to be installed it shall be fastened using a high grade construction adhesive as well as counter sunk screws or concrete masonry anchors.
- 2. System Description
 - A. Cove base shall be installed according to manufacturer's recommendations and shall be:
 - 1. Application area requires prime coat according to 3.04.02
 - 2. Trowel-On Cove Base consisting of a trowel applied radius/base mix with a termination strip installed at the top of the base.
 - B. Cove base will receive a broadcast and top coat consistent with flooring system.

3.7 PATCHING/SLOPING (IF REQUIRED)

- A. Mix polymer concrete components as recommended by the Material Manufacturer.
- B. Use mixture to repair any damaged concrete, or to slope any areas as needed.
- C. Once cured, material must be re-primed before next layer is applied.

3.8 TOPPING

- A. Size the batches, and mix according to Manufacturer's instructions. The entire batch should be poured and spread at once, i.e., do not let material set in pail.
- B. Spread the topping material with a gauge rake set to a depth of 1/8". Lightly trowel to a uniform thickness of 1/8" as necessary.
- C. If necessary, roll with a porcupine roller to release trapped air.
- D. Broadcast colored quartz into the fresh material before it begins to cure. Broadcast by hand, or use a backpack type blower or sand blast pot to achieve an even broadcast. The quartz must 'rain' down and not be thrown into the wet base coat.
- E. Allow the topping to cure.

- F. Remove excess quartz by sweeping, “blow-down”, and/or vacuuming.

3.9 TOP COAT

- A. Apply with clean rollers at a rate of 80 - 100 sq. ft./gal. in the same way as the Silikal Primer was applied as described in Paragraph 3.04.02.
- B. Broadcast aluminium oxide (if required) in accordance with Owner’s specification for slip resistance.
- C. Allow topcoat to cure. Vacuum all dust, paying particular attention to edges and corners.

3.10 SECOND TOP COAT

- A. Apply with clean rollers at a rate of 100 - 125 sq. ft./gal. in the same way as the Silikal Primer was applied as described in Paragraph 3.04.02.
- B. Allow topcoat to cure.

3.11 FIELD QUALITY CONTROL

- A. Applicator shall request acceptance of surface preparation from the Engineer before application of the prime/seal coat.
- B. Applicator shall request acceptance of the prime coat from the Engineer before application of subsequent specified materials.

3.12 CLEANING

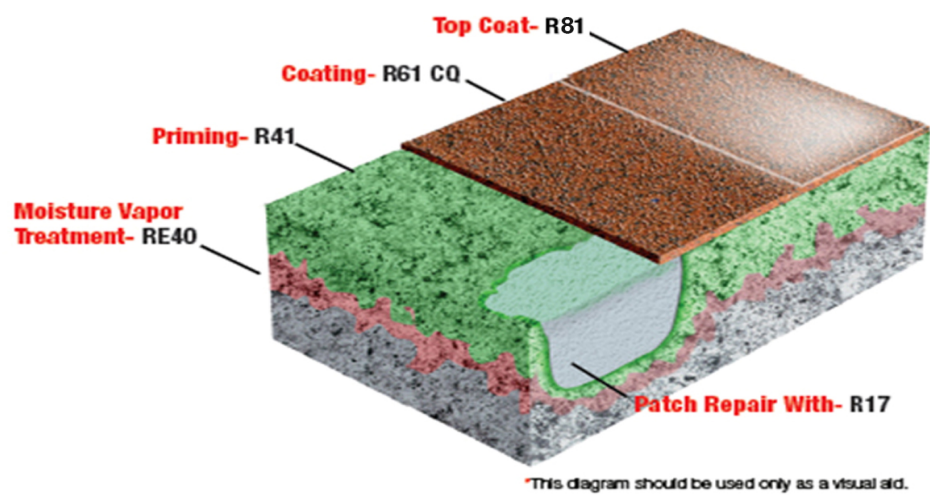
- A. Applicator shall remove any material spatters and other material that is not where it should be. Remove masking and covers taking care not to contaminate surrounding area.
- B. Applicator shall repair any damage that should arise from either the application or clean-up effort.

3.13 JOINT SEALANT

- A. Upon completion of floor system, apply Sika Flex 1A NS polyurethane sealant. Color: Black at base edge of pit / stair steel and floor. Apply on a 45 degree angle to prevent ponding.

3.14 COATING SCHEDULE

- A. Moisture vapor treatment shall be Silikal RE40 application rate shall be approximately 220 sq. ft. per gallon (approx. 7 mils)
- B. Primer shall be Silikal R41 with Additive I Application rate shall be approx. 100 sq.ft. per gallon (approx. 16 mils).
- C. Patching/Sloping material shall be R17
- D. Coving shall be Silikal HK 20 per manufacturers recommendations.
- E. Body coat shall be Silikal R61CQ, applied with a gauge rake set at 1/8” for a rate of 40 sq. ft. per batch. Colored quartz to be broadcast into the uncured topping (optional). Broadcast the quartz at the rate of 0.5 – 0.75 pounds per sq. ft.
- F. Clear topcoat shall be Silikal R81; apply at the rate of 80 - 100 sq. ft. per gallon for the first coat and 90 - 120 sq. ft. per gallon for the second application.



SECTION 09680 CARPET

PART 1 GENERAL

1.0 SUMMARY

- A. Includes the furnishing of all materials, labor, tools, and equipment required for the installation of the carpet floor covering for the entire project as herein specified and indicated on the drawing. Utilize in Office environments only.

1.03 REFERENCE STANDARDS

- A. ASTM E84 tunnel test and other required fire tests as required.
- B. FHA Bulletin UM 44C.

1.04 SAMPLES AND SHOP DRAWINGS

- A. Submit in accordance with Section 01340
- B. Submit one sample of each type of carpet to be used, sufficiently sized to clearly indicate construction.
- C. Clearly indicate the location of all seams, method of joining seams, direction of carpet, type of adhesive to be used, method of integrating edge strips with carpet and installation procedures.

1.05 JOB ENVIRONMENT

- A. Do not commence with carpet installation until painting, finishing, ceilings and overhead work is approved and completed.
- B. Maintain room temperature at minimum 60 degrees F. (15 degrees C.) for at least 24 hours prior to installation and relative humidity at approximately that at which the area is to be maintained.
- C. Provide sufficient lighting.

PART 2 PRODUCT

MANUFACTURER

- A. Consult Owner.

PART 3 EXECUTION

3.0 PREPARATION

- A. Clean floors of dust, dirt, solvents, oil, grease, paint, plaster and other substances which would be detrimental to the proper performance of adhesive and carpet. Allow floors to thoroughly dry.
- B. Insure floors are level with maximum surface variation of 1/4" in 10', noncumulative.
- C. Insure concrete floors are free from scaling and irregularities and exhibit neutrality relative to acidity and alkalinity.
- D. Use an approved cementitious filler to patch cracks, small holes and for leveling.

3.1 INSTALLATION

- A. Lay out rolls of underlayment (if applicable) and carpet for approval.
- B. Check matching of carpet before cutting and insure there is no visible variation between dye lots.
- C. Cut carpet, where required, in a manner to allow proper seam and pattern match. Insure cuts are straight, true and unfrayed.
- D. Where possible and practical, locate seams in areas of least amount of traffic.

- E. Join seams in recommended manner and so as not to detract from the appearance of the carpet installation and decrease its life expectancy. Insure seams are straight, not overlapped or peaked and free of gaps.
- F. Vacuum clean substrate. Spread adhesive in quantity recommended by manufacturer after primer application to ensure proper adhesion over full area of installation. Apply only enough adhesive to permit proper adhesion of carpet before initial set.
- G. Lay carpet on floors with run of the pile in same direction of anticipated traffic.
- H. Do not change run of pile in any one room or from one room to next.
- I. Cut and fit carpet neatly around projections through floor and to walls and other vertical surfaces. Fit carpet snugly to walls or other vertical surface, leaving no gaps.
- J. Completely cover surfaces of steps with no seams on faces of risers or treads. Secure carpet to all concrete surfaces with adhesive.
- K. Do not place heavy objects such as furniture on carpeted surfaces for minimum 24 hours or until adhesive has set.
- L. Entire carpet installation is to be laid tight and flat to subfloor, well-fastened at edges and present a uniform, pleasing appearance. Insure monolithic color, pattern and texture match within any one area.
- M. Install edging strips where carpet terminates at other floor coverings. Use full length pieces only. Butt tight to vertical surfaces. Where splicing cannot be avoided, butt ends tight and flush.

3.2 ADJUSTING AND CLEANING

- A. Repair all frayed edges and stretch mars.
- B. Ensure all terminations are tight and fully secure.
- C. All carpet shall be cleaned upon completion of installation.

SECTION 09901 - CORROSION PROTECTION**PART 1 GENERAL****1.0 DEFINITION**

- A. This specification covers the requirements governing the selection and application of the coating system to be used on the pit steel components, open steel staircases, and miscellaneous structural steel susceptible to corrosion.

1.2 GENERAL

- A. The following surfaces are not required to be coated:
 - 1. Prefinished aluminum metals
 - 2. Product tubing, air lines, water lines, conduit, etc.
 - 3. Nameplates, machined surfaces, instrument glass, flanged faces, control valve stems and similar items.
 - 4. Ferrous metals not susceptible to corrosion.

1.3 WARRANTY

- A. Contractor shall guarantee that the application fulfills all conditions as stated in the Corrosion Protection specifications. Should any workmanship covered by these specifications be proven defective within the guarantee period, of 3 years, Contractor shall repair or replace the workmanship without charge to Owner.
- B. The product manufacturer shall guarantee that the materials satisfactorily perform for a period of 3 years. Should any materials covered by these specifications be proven defective within the guarantee period, of 3 years, the product manufacturer shall repair or replace the workmanship without charge to Owner.
- B. Any deviation from this specification shall be approved in writing by Company. Failure of applicator to consult with Owner representative to clarify any item in the specification will in no way relieve the Contractor of his responsibility for satisfactory compliance with these specifications.

1.4 CODES AND STANDARDS

The Fabricator shall comply with the applicable provisions of the following specifications:

- A. Steel Structural Painting Council (SSPC)
 - PA-1 Shop, Field and Maintenance Painting
 - SP-1 Solvent Cleaning
 - SP-2 Hand Tool Cleaning
 - SP-3 Power Tool Cleaning
 - SP-5 White Metal Blast Cleaning (NACE No. 1)
 - SP-6 Commercial Blast Cleaning (NACE No. 2)
 - SP-7 Brush-Off Blast Cleaning
 - SP-10 Near White Blast Cleaning (NACE No. 2)
- B. American Society for Testing and Materials (ASTM)
 - A-90 Weight of coating on zinc-coated (galvanized) iron and steel articles.
 - A-120 Black and hot dipped zinc-coated (galvanized) welded and seamless steel pipe for ordinary users.
 - A-123 Zinc (hot-galvanized) coatings on product fabricated from rolled, pressed, and forged steel shapes, plates, bars and strip.
 - A-143 Safeguarding against embrittlement of hot galvanized structural steel products.
 - A-153 Zinc coating (hot dip on iron and steel hardware).
 - A-164 Electro deposited coatings of zinc on steel.

- A-385 Recommended practice for providing high quality zinc coatings (hot-dip) on assembled products.
- A-563 Carbon steel nuts.
- C. Pictorial Surface Preparation Standards For Painting Steel Structures
 - SSPC-SP2 Swedish Visual Std. St. 2
 - SSPC-SP3 Swedish Visual Std. St. 3
 - SSPC-SP5 Swedish Visual Std. St. 3 (NACE No. 1)
 - SSPC-SP6 Swedish Visual Std. Sa 2
 - SSPC-SP7 Swedish Visual Std. Sa 1
 - SSPC-SP10 Swedish Visual Std. Sa 2-1/2 (NACE No. 2)

1.5 QUALITY ASSURANCE

- A. All work and materials applied under this specification shall be subject to inspection by Owner representative.
- B. If deemed necessary, the Owner may elect to test each coat of paint for dry film thickness (d.f.t.) using a dry film gauge of the Mikrotest type or an approved equivalent. The U.S. Bureau of Standards Precise Film Thickness Card shall be used to calibrate the instrument prior to its use.
- C. All surfaces to which coatings are applied shall be free of dirt, grease, chemicals, and other contamination.
- D. The completed coating shall be inspected by the Owner's representative for runs, overspray, and roughness, holidays and any signs found to show these or other evidence of improper application shall require repair or recoating in accordance with the manufacturer's recommendations at Contractor's expense.

PART 2 PRODUCTS

- A. MANUFACTURER
 - Sherwin Williams Corothane I Preprime
 - Sherwin Williams Epoxy Mastic Aluminum II
 - Sherwin Williams Acrolon 218 HS

2.1 PERFORMANCE CHARACTERISTICS

- A. Sherwin Williams Corothane I Preprime
 - 1. Abrasion Resistance:
 - Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
 - Result: 88 mg loss
 - 2. Direct Impact Resistance:
 - Method: ASTM D2794
 - Result: 40 in. lbs.
 - 3. Flexibility:
 - Method: ASTM D522, 180° bend, 1/8" mandrel
- B. Sherwin Williams Epoxy Mastic Aluminum II
 - 1. System Tested: (unless otherwise indicated)
 - Substrate: Steel
 - Surface Preparation: SSPC-SP6
 - Finish: 1 ct. Epoxy Mastic Aluminum II
 - @ 5.0 mils dft/ct
 - 2. Abrasion Resistance:
 - Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
 - Result: 124 mg loss
 - 3. Adhesion:
 - Method: ASTM D4541
 - Result: 1000+ psi
 - 4. Direct Impact Resistance:

- Method: ASTM D2794, 1/4" steel
- Result: 160 in. lbs.
- 5. Dry Heat Resistance:
 - Method: ASTM D2485
 - Result: 200°F
- 6. Exterior Durability:
 - Method: 1 year 45° South
 - Result: Excellent, chalks
- 7. Flexibility:
 - Method: ASTM D522, 180° bend, 3/4" mandrel
 - Result: Passes
- 8. Moisture Condensation Resistance:
 - Method: ASTM D4585, 100°F, 1500 hours
 - Result: No blisters, rust, or delamination
- 9. Pencil Hardness:
 - Method: ASTM D3363
 - Result: 2H
- 10. Salt Fog Resistance:
 - Method: ASTM B117, 1000 hours
 - Result: No blistering, cracking, softening, or delamination.
- 11. No more than 1/8" rust creepage.
 - Rating 10 per ASTM D610 for rusting.
- C. Sherwin Williams Acrolon 218 HS
 - 1. System Tested: (unless otherwise indicated)
 - Substrate: Steel Surface Preparation: SSPC-SP10
 - 1 ct. Macropoxy 646 @ 6.0 mils dft
 - 1 ct. Acrolon 218 HS Gloss @ 4.0 mils dft
 - 2. Abrasion Resistance: 1
 - Method: ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load
 - Result: 43 mg loss
 - 3. Adhesion:
 - Method: ASTM D4541
 - Result: 975 psi
 - 4. Corrosion Weathering: 2
 - Method: ASTM D5894, 9 cycles, 3024 hours
 - Result: Rating 10 per ASTM D610, for rusting
 - 5. Rating 10 per ASTM D714, for blistering
 - Direct Impact Resistance: 1
 - Method: ASTM D2794
 - Result: 50 in. lb.
 - 6. Dry Heat Resistance: 1
 - Method: ASTM D2485, Method A
 - Result: 200°F
 - 7. Flexibility: 1
 - Method: ASTM D522, 180° bend, 1/8" mandrel
 - Result: Passes
 - 8. Humidity Resistance: 2
 - Method: ASTM D4585, 100°F, 1500 hours
 - Result: Rating 10 per ASTM D610 for rusting
 - Rating 10 per ASTM D714 for blistering
 - 9. Pencil Hardness:
 - Method: ASTM D3363
 - Result: 3H
 - 10. Salt Fog Resistance: 2
 - Method: ASTM B117, 7000 hours
 - Result: Rating 10 per ASTM D610 for rusting

Rating 9 per ASTM D714 for blistering

1. Finish coat only tested
2. Primer Zinc-Clad II Plus
Intermediate Macropoxy 646
Finish Acrolon 218 HS

Meets the requirements of SSPC Paint No. 36, Level 3.

PRODUCT CHARACTERISTICS

A. Sherwin Williams Corothane I Preprime

Finish: Semi-Gloss

Color: Clear / Amber Cast – Do not Tint

Volume Solids: 62% $\pm$ 2%

Weight Solids: 68% $\pm$ 2%

VOC (calculated): <340 g/L; 2.80 lb/gal

Recommended Spreading Rate per coat:

Wet mils: 2.5 - 3.0

Dry mils: 1.5 - 2.0

Coverage: 497 - 663 sq ft/gal approximate

Drying Schedule @ 3.0 mils wet @ 50% RH:

@55°F @ 77°F @100°F

To touch: 3 hours 1-1/2 hours 20 minutes

To recoat minimum: 8 hours 3-1/2 hours 1 hour

maximum: 30 days 30 days 15 days

To cure: 4 days 3 days 1 day

Drying time is temperature, humidity, and film thickness dependent.

Abrade surface if maximum recoat time is exceeded.

Shelf Life: 12 months, unopened

Store indoors at 40°F to 100°F.

Flash Point: 105°F, PMCC

Reducer/Clean Up: Reducer #15, R7K15

B. Sherwin Williams Epoxy Mastic Aluminum II

Finish: Flat

Color: Aluminum

Volume Solids: 78% $\pm$ 2%, mixed

ASTM D2697 (disk method)

80% $\pm$ 2%, mixed, calculated

ASTM D5201

Weight Solids: 89% $\pm$ 2%, mixed

VOC (EPA Method 24): Unreduced: <180 g/L; 1.50 lb/gal

mixed Reduced 10%: <235 g/L; 1.96 lb/gal

Mix Ratio: 1:1 by volume

Recommended Spreading Rate per coat:

Wet mils: 5.0 - 7.5

Dry mils: 4.0 - 6.0

Coverage: 214 - 320 sq ft/gal approximate

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 7.5 mils wet @ 50% RH:

@ 35°F @ 50°F @ 77°F @ 120°F

To touch: 20 hours 10 hours 2½ hours 1 hour

Tack free: 60 hours 24 hours 5 hours 3 hours

To recoat:

minimum: 4 days 24 hours 6 hours 3 hours

maximum: 1 year 1 year 1 year 1 year

To cure: 21 days 21 days 10 days 7 days

Pot life: 6 hours 5 hours 3 hours 1½ hours

Sweat-in-time: 45 minutes 30 minutes 15 minutes 10 minutes

If maximum recoat time is exceeded, abrade surface before recoating.

Drying time is temperature, humidity, and film thickness dependent.

Shelf Life: 12 months, unopened

Store indoors at 40°F to 100°F

Flash Point: 102°F, PMCC, mixed

Reducer/Clean Up: Below 80°F - Xylene, R2K4

Above 80°F - Reducer #100, R7K100

C. Sherwin Williams Acrolon 218 HS

Finish: Semi-Gloss

Color: Valvoline Red

Volume Solids: 65% ± 2%, mixed, may vary by color

Weight Solids: 78% ± 2%, mixed, may vary by color

VOC (EPA Method 24): Unreduced: <300 g/L; 2.5 lb/gal

mixed Reduced 10%: <340 g/L; 2.8 lb/gal

Mix Ratio: 6:1 by volume, 1 gallon or 5 gallon mixes

premeasured components

Recommended Spreading Rate per coat:

Wet mils: 4.5 - 9.0

Dry mils: 3.0 - 6.0

Coverage: 175 - 346 sq ft/gal approximate

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 6.0 mils wet @ 50% RH:

@ 50°F @ 77°F @ 120°F

To touch: 2 hours 30 minutes 20 minutes

To handle: 10 hours 6 hours 4 hours

To recoat:

minimum: 12 hours 8 hours 6 hours

maximum: 3 months 3 months 3 months

To cure: 14 days 7 days 5 days

Drying time is temperature, humidity, and film thickness dependent.

Pot Life: 4 hours 2 hours 45 minutes

(reduced 5% with Reducer R7K15)

Sweat in Time: none none none

If maximum recoat time is exceeded, abrade surface before recoating.

Shelf Life: Part A: 36 months, unopened

Part B: 12 months, unopened

Store indoors at 40°F to 100°F

Flash Point: 55°F, Seta, mixed

Reducer/Clean Up: Spray Reducer R7K15

Brush/Roll Reducer #132, R7K132

PART 3 EXECUTION

3.0 PREPARATION

- A. All local mounted instruments, gauges, nameplates, control valve stems, code stamps, and electrical fixtures shall be protected to prevent damage during blasting and painting. Nameplates, which are attached in a manner that will allow corrosion to occur behind the nameplate, shall be removed prior to waterblasting and painting and then reattached after painting is completed.
- B. Use low moisture steam cleaning to remove grease, oil, and any other foreign contamination from the surface of all steel & concrete. Solvent cleaning may be necessary between coats to remove recontamination.

- C. All abrasive material will be absolutely clean and dry. Filters necessary to accomplish this will be provided in the compressors and elsewhere as needed. No oil and no moisture of any kind will be acceptable.
- D. All oil and/or grease contaminations shall be removed by solvent washing SSPC-SP-1-63 "solvent cleaning" before starting water blasting.
- E. Coating and curing shall be done in such a manner to anticipate that the coating will be able to cure for a minimum of six hours at relative humidity less than 85%.
 - 1. Complete curing and maximum chemical resistance of the coating may take up to 7 days at 77 degrees F.
- F. No water blasting shall be permitted on copper surfaces, control valves and electric motor drivers. All oil/grease, dirt, scale, or flaking paint, and other contamination shall be removed prior to external painting.

3.1 MIXING, THINNING AND STORAGE

- A. Paint must be kept in fully enclosed storage room within maximum and minimum temperature limitations and time restraints of storage to agree with manufacturer's recommendations. Unless more restrictive positions are given by the coating manufacturer's storage requirements, paint should be kept in fully enclosed storage at temperatures greater than 40°F, and less than maximum storage temperature as per manufacturer's recommendation.
- B. All containers of coating material shall remain unopened until required for use. Only enough containers shall be opened that will be used during one day. Any coating material remaining in a container which was opened more than 24 hours earlier will not be used.
- C. Coating materials which have jelled or otherwise deteriorated during storage shall not be used and shall be removed from site.
- D. All coating ingredients in any container shall be thoroughly and completely mixed by power-driven mixers before use to a smooth and uniform consistency. For two (2) component systems, the components, and catalyst and the coating, shall be thoroughly mixed.
- E. Coating material mixed in the original container shall not be transferred until all settled pigment is incorporated in the vehicle. This does not imply that part of the vehicle may not be poured off temporarily to simplify the mixing.
- F. Coating material shall not be mixed or kept in suspension by using a bubbling air stream.
- G. Where a skin has formed in the container, the skin shall be cut loose and discarded. If such skins are sufficiently thick to have a practical effect on the composition and quality, the paint shall not be used.
- H. All pigmented material shall be strained after mixing except where application equipment is provided with adequate strainers. Strainers shall be capable of passing the pigment and removing any skin.
- I. Material which does not have a limited pot life, or does not deteriorate on standing may be mixed any time before using, but if settling has occurred, material shall not remain in spray pots or buckets overnight but shall be gathered into a closed container and remixed before use.
- J. No thinner shall be added unless necessary for proper application. Thinning shall not exceed limitations established by manufacturer.
- K. Type of thinner shall comply with manufacturer's instruction.
- L. When use of thinner is permissible, it shall be added during the mixing process. Painters shall not add thinner after paint has been thinned to the proper consistency. All thinning shall be done under supervision of one acquainted with the correct amount and type to be added.

PREPARATION

- A. Work shall be performed off-site to the extent possible.
- B. General Surface Preparation
 - 1. Minimum surface preparation is Hand Tool Clean per SSPCSP2.
 - 2. Clean all surfaces an abrasive method as recommended by the manufacturer for the specific application.
 - 3. When surfaces are thoroughly clean, dry and contaminant free, prime any bare steel within 8 hours or before.
- C. Sherwin Williams Corothane I Preprime
 - 1. Surface Preparation:
 - a. Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.
 - b. Refer to product Application Bulletin for detailed surface preparation information.
 - c. Minimum recommended surface preparation: Iron & Steel: SSPC-SP2 or SP3
 - 2. Application Conditions:
 - a. Temperature: air and surface: 20°F minimum, 100°F maximum material: 45°F minimum
 - b. Do not apply over surface ice
 - c. Relative humidity: Can be applied at relative humidities up to 99%.
 - d. Refer to product Application Bulletin for detailed application information.
- D. Sherwin Williams Epoxy Mastic Aluminum II
 - 1. Surface Preparation :
 - a. Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.
 - b. Refer to product Application Bulletin for detailed surface preparation information.
 - c. Minimum recommended surface preparation:
 - 1) Iron & Steel: SSPC-SP2
 - 2) Aluminum: SSPC-SP1
 - 3) Galvanizing: SSPC-SP1
 - 2. Application Conditions:
 - a. Temperature: 35°F minimum, 120°F maximum (air, surface, and material) at least 5°F above dew point
 - b. Relative humidity: 85% maximum
 - c. Refer to product Application Bulletin for detailed application information.
- E. Sherwin Williams Acrolon 218 HS
 - 1. Surface Preparation:
 - a. Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.
 - b. Refer to product Application Bulletin for detailed surface preparation information.
 - c. Minimum recommended surface preparation:
 - 1) Iron & Steel: SSPC-SP6/NACE 3, 1-2 mils pro
 - 2) Galvanizing: SSPC-SP1
 - 3) Primer required
 - 2. Application Conditions:
 - a. Temperature: 40°F minimum, 120°F maximum (air, surface, and material) at least 5°F above dew point Relative humidity: 85% maximum

- b. refer to product Application Bulletin for detailed application information.

3.3 GENERAL COATING PROCEDURE

- A. The type, brand, number of coats, color, and thickness shall be as specified in scope of work.
- B. Primer and finish coats for any particular system shall be from the same manufacturer to ensure compatibility.
- C. Manufacturer's instructions, including safety precautions, are a part of this specification. In case of conflict, the more stringent instructions shall govern.

3.4 GENERAL COATING APPLICATION

- A. Surfaces shall be coated according to specific manufacturer's specifications. In any event, surfaces shall not be coated in rain, wind, snow, fog, mist, dust or in areas where injurious airborne elements exist.
- B. Water blast cleaned surfaces shall be coated with one complete application of primer as soon as practicable but in no case later than four (4) hours after blasting.
- C. To the maximum extent practicable, each coat of material shall be applied as a continuous film of uniform thickness free of pores. Any thick spots or areas missed on the application shall be recoated and permitted to dry before the next coat is applied, or in accordance with manufacturer's recommendation.
- D. Each coat shall be in a proper state of cure or dryness before the application of the succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the undercoat, and after the manufacturer's minimum recommended drying time has elapsed.
- E. Alternate coats shall be tinted sufficiently (if acceptable by manufacturer) to produce enough contrast to indicate complete coverage of the surface. When the paint is the color of the steel, or when the tinting of the final coat is objectionable, the first coat to be applied shall be tinted. The tinting material must not be detrimental to the service life of the paint.
- F. For each applied coat to structural shapes the edges shall receive the first pass of the coat followed directly by the coating of the remaining surfaces.

3.5 AIR SPRAY APPLICATION

- A. Owner approval is required to perform air spray application.
- B. The equipment used shall be suitable for the intended purpose, capable of properly atomizing the paint to be applied, and equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.
- C. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and the drain valves must be opened slightly to permit continuous draining of condensate during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.
- D. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.
- E. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of the paint, excessive evaporation of solvent, or loss by over spray.
- F. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted. Equipment shall be purged with thinner compatible with product to be sprayed.

- G. Paint shall be applied in a uniform layer, with 50% overlapping at the edge of the spray pattern. The spray pattern shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and at a distance as recommended by the paint manufacturer which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke and restarted only after forward motion of the gun has started.
- H. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.
- I. Areas inaccessible to the spray gun shall be painted per Section 8.4 of this specification.

3.6 BRUSH APPLICATION

- A. Coatings shall be brushed on all areas.
- B. Brushes shall be of a style and quality that will enable proper application of paint. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough or pitted steel. Wide, flat brushes are suitable for large flat areas, but they shall not have a width over five inches.
- C. The brushing shall be done so that a smooth coat as nearly uniform in thickness as possible is obtained.
- D. Paint shall be worked into all corners.
- E. Any runs or sags shall be brushed out.
- F. There shall be a minimum of brush marks in the coat of applied paint.
- G. Successive coats of paint shall be applied by crosshatching the previous coat.
- H. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

3.7 GENERAL CONSIDERATION AND PROTECTION

- A. For surfaces to be painted, which cannot be abrasive blasted, remove all oil film, dirt, scale or flaking paint preferably using solvent. Where flaking paint or scale is removed, all rough edges shall be feathered. Power brushing can be used; however, care must be taken not to burnish the metal surface as paint will not then adhere. Application by means of brush or spray is acceptable using procedures as previously outlined.
- B. All nameplates, manufacturer's identification tags, instrument glass, finished flange faces, control valve stems and similar items shall be cleaned and restored to its original condition.
- C. Wet paint shall be protected against contamination from dust or other foreign matter.
- D. Paint shall be protected from rain, condensation, contamination, snow and freezing to the fullest extent practical until cured.
- E. Primer coat thickness is critical to paint system integrity and shall meet the required specification.
- F. Manufactured items such as valves and level gauges shall be coated according to this specification. Unless specifically approved by Company, manufacturer's paint system is not acceptable and therefore, Fabricator shall blast and paint the item per this specification.

3.8 DRYING OF COATED SURFACES

- A. No paint shall be force dried under conditions which will cause checking, wrinkling, blistering, formation of pores, or detrimentally affect the condition of the paint.
- B. No drier shall be added to a paint on the job unless specifically called for in the manufacturer's specification for the paint, or approved by Owner.

3.9 REPAIR OF DAMAGED PAINT SURFACES

- A. Any improperly coated surfaces shall be solvent cleaned, hand or power tool cleaned and then re-primed and painted if not completely coated.

3.10 CLEAN UP

- A. All paint brushes, sprayers, pans, rollers, etc. must be cleaned off-site.

- B. The contractor shall, at all times, keep the premises free from accumulation of waste materials or rubbish. At the completion of the work the jobsite shall be completely cleaned of any evidence of construction materials or debris.

3.11 JOINT SEALANT

- A. Upon completion of painting of pit / stair steel, cracks, crevices, and voids along the steel and concrete and ceiling of pit area should be filled with a MCU single component caulk/sealant as follows:
 - 1. This process shall begin with solvent cleaning or low moisture steam cleaning of the concrete and steel to remove all, oil, grease, dirt, and any other foreign contaminants.
 - 2. The cracks, voids, and crevices should then be cleaned out.
 - 3. Remove any loose paint, concrete, dirt, debris, etc.
 - 4. Surface must be dry, and clean before sealant is applied.
 - 5. If necessary, install foam backer rod into crevices and cracks to provide a base for the sealant.
 - 6. Fill cracks and crevices with sealant and make surface level.
 - 7. Allow first application to dry completely.
 - 8. Apply second application at a 45 degree angle to prevent ponding of any excess fluid buildup.
- B. Acceptable products:
Sika 1A NS smooth Stone MCU single component sealant or SW Stampede 1 MCU smooth NS sealant/Stone # 163-7537

SECTION 09910 – EXTERIOR PAINTING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Steel.
 - 2. Galvanized metal.
 - 3. Masonry
 - 4. Asphalt and concrete driveways.
- B. Related Sections include the following:
 - 1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
 - 3. Division 9 Section "Staining and Transparent Finishing"

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- E. Qualification Data: For Applicator.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain primers for each coating system from the same manufacturer as the finish coats.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.

1.5 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Sherwin-Williams Company.

2.0 PAINT, GENERAL

- A. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions
- C. Colors: As selected by Owner from manufacturer's full range and as noted in Paint Schedule portion of these specifications.

2.2 METAL PRIMERS

- A. All galvanized and metal surfaces shall be primed with Sherwin-William's Pro-Cryl Primer prior to application of specified finish coats.

PART 3 EXECUTION**3.0 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
 - 1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.1 PREPARATION

- A. Remove machined surfaces and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and re-prime substrate with compatible primers as required to produce paint systems indicated.
 - 2. Existing facilities that are to be painted must be thoroughly pressure washed prior to paint application.
- C. All galvanized and metal surfaces shall be cleaned with solvent or non-hydrocarbon cleaner as recommended by the coating manufacturer prior to priming with metal primers. Rust area shall be prepared per SSPC-SP2 or SP3 Hand or Power Tool Cleaning and
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
- E. Use only thinners approved by paint manufacturer and only within recommended limits. Any moisture problems such as roof leaks, improper grading, etc., must be corrected prior to paint application.

3.2 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the room finish schedule.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

5. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- B. If the primer can be tinted, tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. Do not apply additional coats if previous coat has exceeded the re-coat window. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - a. All surfaces shall receive a minimum of (2) finish coats of paint according to paint manufacturer's recommendations.
 2. Omit primer over metal surfaces that have been shop primed and touchup painted.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion
- D. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
 1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet-back, synthetic fiber or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- E. Minimum – Maximum Coating Thickness: Apply paint materials no less than manufacturer's recommended minimum spreading rate or more than maximum per coat to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- F. Wainscote paint shall stop at doors and frames. Entire door and frame shall be painted one color as noted in the drawings and Paint Schedule.
- G. Apply Sher-Clear over exterior Valvoline Red paints in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will perform tests for compliance of paint materials with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying paint materials from Project site, pay for testing, and repaint surfaces

painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Owner, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 EXTERIOR PAINTING SCHEDULE

- A. Refer to drawings for finishes.

REVISED 1/4/16

SECTION 09920 - INTERIOR PAINTING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Steel.
 - 2. Gypsum board.
 - 3. Wood.
 - 4. Masonry
- B. Related Sections include the following:
 - 1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
 - 2. Section 09910 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.
 - 3. Section 09901 Corrosion Protection for surface preparation, priming and paint application of steel susceptible to corrosion (ie. Pit steel, stairs, etc.).

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- E. Qualification Data: For Applicator:

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain primers for each coating system from the same manufacturer as the finish coats.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.

- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.

1.5 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Sherwin-Williams Company.

2.1 PAINT, GENERAL

- A. Material Compatibility: Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions
- C. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
 - 1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
 - 2. Non-flat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
 - 3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
- D. Chemical Components of Field-Applied Interior Paints and Coatings: Provide topcoat paints and anti-corrosive and anti-rust paints applied to ferrous metals that comply with

the following chemical restrictions; these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop.

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
- E. Colors: Refer to finish legend on drawings.

2.2 PRIMERS/SEALERS

- A. Interior Gypsum Board Primer: Factory-formulated latex-based primer for interior application.
1. Sherwin-Williams; ProMar 200 Zero VOC Latex Wall Primer B28W2600 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.3 METAL PRIMERS

- A. Interior Ferrous-Metal Primer: Factory-formulated quick-drying rust-inhibitive alkyd-based metal primer.
1. Sherwin-Williams; Pro-Cryl Primer B66-310 Series applied at a dry film thickness of not less than 3.0 mils. Refer to Section 09901 Corrosion Protection for steel members requiring more stringent Corrosion Protection application procedures.

2.4 WOOD PRIMERS

- A. Interior Wood Primer for Acrylic-Enamel Finishes: Factory-formulated alkyd- or acrylic-latex-based interior wood primer.
1. Sherwin-Williams; Premium Wall & Wood Primer B28W8111 Series: Applied at a dry film thickness of not less than 1.6 mils.

2.5 MASONRY PRIMERS

- A. Sherwin Williams Heavy Duty Block Filler B42W46.

2.6 PLASTIC PRIMERS

- A. XIM/UMA Bonding Primer
B. Sherwin Williams Multi-Purpose Latex Primer B51W450 Series

2.7 INTERIOR FINISH COATS

- A. [High Performance ambient cured, one component acrylic coating with excellent performance properties for interior application.](#)
1. Sherwin-Williams; [SHER-CRYL™ HPA, HIGH PERFORMANCE ACRYLIC](#). Applied at a dry film thickness of not less than [2.2](#) mils.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application. Comply with procedures specified in PDCA P4.
1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify Owner about anticipated problems when using the materials specified over substrates primed by others.
- C. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- D. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Wood: 15 percent.
 - 2. Gypsum Board: 12 percent.

3.1 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved
 - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings, including dirt, oil, grease, and incompatible paints and encapsulants. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
 - 2. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- C. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.
 - 1. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
 - 2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - 3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat
- D. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum-based solvents or non-hydrocarbon cleaner as recommended by the manufacturer so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- E. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- F. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.
- G. For painting over previously painted surfaces, test the surface to determine if the previously painted surface is oil or latex and utilize a manufacturer recommended primer.

- H. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
 - 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.2 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
 - 1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convactor covers, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 - 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 6. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 - 7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces. Do not carry wainscote application through door areas. Doors and frames shall be one color as specified in the paint schedule.
 - 8. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
 - 1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. Do not apply additional coats if previous coat has exceeded the re-coat window. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 - 2. Omit primer over metal surfaces that have been shop primed and touchup painted.
 - 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 - 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.
- D. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, synthetic fiber or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- E. Minimum – Maximum Coating Thickness: Apply paint materials no less than manufacturer's recommended spreading rate or more than the maximum per coat to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- F. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.
- G. Painting Mechanical and Electrical Work: Paint items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
 1. Mechanical Work:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
 - e. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - f. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
 2. Electrical Work:
 - a. Panelboards.
 - b. Electrical equipment that is indicated to have a factory-primed finish for field painting.
- H. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- J. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements

3.3 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
 1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Owner, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

- A. A minimum of two finish coats shall be applied.
- B. Refer to drawings for finishes.

Revised 8/15/2019

SECTION 09930 - STAINING AND TRANSPARENT FINISHING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes surface preparation and the application of wood finishes on the following substrates:
 - 1. Exterior Substrates:
 - a. Wood fence and gates
- B. Related Sections include the following:
 - 1. Division 09 Section "Exterior Painting" for surface preparation and application of standard paint systems on exterior substrates.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.
 - 1. Submit Samples on representative samples of actual wood substrates, 8 inches square.
 - 2. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
- E. Qualification Data: For Applicator.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Final approval of stain color selections will be based on benchmark samples.
 - 1. If preliminary stain color selections are not approved, apply additional benchmark samples of additional stain colors selected by Architect at no added cost to Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.

1.5 PROJECT CONDITIONS

- A. Apply finishes only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 PRODUCTS**2.0 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cabot

2.1 MATERIALS, GENERAL

- A. Material: Cabot semi-solid acrylic 1400 series
- B. Stain Colors: Cabot Dark Grey Semi-solid stain
- C. Finish: satin

PART 3 - EXECUTION**3.0 EXAMINATION**

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
 - 1. Maximum Moisture Content of Wood Substrates: 15 percent when measured with an electronic moisture meter.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes.
 - 3. Begin finish application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 4. Beginning application of finish system constitutes Contractor's acceptance of substrate and conditions.

3.1 PREPARATION

- A. General: Remove hardware and hardware accessories, and similar items already installed that are not to be finished.
 - 1. After completing finish operations, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying finish or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Surface Preparation: Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.

- C. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - 1. Stain or seal wood to be finished in field immediately on delivery.

3.2 APPLICATION

- A. Apply finishes according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for finish and substrate indicated.
 - 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
- B. Completed Work: Match approved samples for color texture, and coverage. Remove and refinish work not complying with requirements.

3.3 FIELD QUALITY CONTROL

- A. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when finishes are being applied:
 - 1. Owner will engage the services of a qualified testing agency to sample finish materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying finishes if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces if, on refinishing with complying materials, the two finishes are incompatible.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

SECTION 10261 – CORNER WALL PROTECTION**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 RELATED SECTIONS

- A. Section 06640: Plastic Paneling

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Corner guards.

1.3 SUBMITTALS

- A. Samples: If requested by Owner, provide one sample for exposed finish required, as indicated below.
 - 1. Corner Guards: 6 inches long.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain impact-resistant wall-protection units through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store wall-protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

PART 2 PRODUCTS**2.0 MATERIALS**

- A. Stainless-Steel Sheet: ASTM A 240.
- B. Fasteners: Non-magnetic stainless-steel, or other non-corrosive metal screws, bolts, and other fasteners compatible with stainless steel corner guards being fastened.

2.1 CORNER GUARDS

- A. Surface-Mounted, Metal Corner Guards: Fabricated from 1-piece, formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
 - 1. Manufacturers:
 - a. ARDEN Architectural Specialties, Inc.
 - b. Balco, Inc.
 - c. Construction Specialties, Inc.
 - d. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - e. Pawling Corporation.
 - 2. Material: Stainless steel, Type 304.
 - a. Thickness: Minimum 0.0625 inch.
 - b. Finish: Directional satin, No. 4.

3. Wing Size: Nominal 1 ¼" by 1 ¼" inches.
4. Corner Radius: 1/8 inch.
5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.

2.2 FABRICATION

- A. Fabricate wall-protection units to comply with requirements indicated for design, dimensions, and member sizes.
- B. Provide surfaces free of dents, uneven coloration, and other imperfections. Fabricate members and fittings flush and smooth.

2.3 METAL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 1. Remove tool and die marks and stretch lines or blend into finish.
 2. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- B. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall-protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.2 INSTALLATION

- A. General: Install wall-protection corner guards plumb and true to line without distortions. Do not use materials with stains, dents, or other defects that might be visible in the finished Work.
 1. Install impact-resistant wall-protection units in locations and at mounting heights indicated on Drawings.

SECTION 10262 – BUMPER GUARDS**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 RELATED SECTIONS

- A. Section 06640: Plastic Paneling

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Bumper Guards for use on Podium corners.

1.3 SUBMITTALS

- A. Samples: If requested by Owner, provide one sample for exposed finish required, as indicated below.
 - 1. Bumper Guards: 6 inches long.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain bumper units through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store bumper guards in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

PART 2 PRODUCTS**2.0 MATERIALS**

Dimensions: ext. dia. 1.5"
x 39.5" L
Color: Yellow & Black
Composition: Polyurethane
foam
Weight: 1.14 lbs.
Dimensions
(Wing): 1" W
Style: 90 degree
corner

2.1 BUMPER GUARDS

- A. Surface-Mounted, Polyurethane Foam Bumper Guards: Fabricated from 1-piece, formed or extruded foam with 90 degree.
 - 1. Manufacturers:

- a. New Pig, Inc. Contact 800-468-4647
2. Mounting: Self adhesive.

2.2 FABRICATION

- A. Fabricate wall-protection units to comply with requirements indicated for design, dimensions, and member sizes.
- B. Provide surfaces free of dents, uneven coloration, and other imperfections. Fabricate members and fittings flush and smooth.

2.3 PREPARATION

- A. Before installing the corner protectors, thoroughly remove any old bumper guard material and adhesive. Once this is complete, thoroughly clean the corner with paint thinner to remove grease and grime.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Bumper Guards shall be installed on the front of standard podium units only. Not to be used for fold-up podiums.
 1. For standard units located against a wall, only the pit side corner will require a bumper guard. For standard units located between pit openings, both front corners will require a bumper guard.
- B. Bumper Guards come in lengths of 39-1/2". Each corner protector will need to be cut in 8-1/2" lengths.
- C. The Bumper Guards should be cut neatly and squarely utilizing a sharp utility knife or Exacto knife.
- D. Remove the glue strip protection on the back of the guard material and firmly apply to the podium corner.
- E. Ensure the material is secure.

3.2 CLEANING

- A. Remove any smudges, grease, grime, etc. with products approved by manufacturer.

SECTION 10430 – EXTERIOR SIGNS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Exterior signs shall be furnished and installed by Owner. Electrical feeds, free-standing sign foundation and monument base shall be installed by the General Contractor for new ground-up projects.
- B. This Section includes the following:
 - 1. Exterior signs.
- C. Related Sections include the following:
 - 1. Division 5 "Metals"
 - 2. Division 7 "Weatherproofing"
 - 3. Division 7 "Joint Sealants"
 - 4. Division 7 "Sheet Metal Flashing and Trim"
 - 5. Division 26 Sections for electrical service and connections for illuminated signs.
 - 6. Division 26 Section "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
 - 7. Division 26 Section "Interior Lighting" for illuminated Exit signs.
 - 8. Division 31 "Earthwork"
 - 9. Division 32 Section "Landscaping"
 - 10. Division 32 "Property Improvements"

1.2 SUBMITTALS

- A. Product Data: Furnished by Owner's vendor for each type of product indicated.
- B. Shop Drawings: Provided by Owner's vendor. Show fabrication and installation details for signs.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Provide message list, typestyles, graphic elements, including tactile characters and layout for each sign.

1.3 QUALITY ASSURANCE

- A. Installers shall be noted in the industry as "A" installers and shall be approved by Owner prior to award of the work.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Survey openings, facility support structure, electrical, anchoring requirements, positioning, property boundaries, etc. by field inspection before fabrication and indicate as applicable on Shop Drawings.
- B. Notify Owner of any obstructions that may hinder full view of proposed signage.
- C. Verify Owner proposed drawings, manufacturer's shop drawings and actual project conditions. Notify Owner of any discrepancies.
- D. If the facility is currently an operating unit, schedule work with Owner to minimize disturbance to business operations. This may require after hours work if installation deters customers from easy ingress and egress. In no case shall work at operating facilities occur on a Saturday.

- E. Contractor must meet Owner's minimum insurance requirements.
- F. Prior to excavating, applicable utility companies shall approve excavation limits.
- G. Do not install heavy signs when conditions, such as weather prohibits the use of a crane.

1.5 STORAGE AND HANDLING

- A. Signs shall be covered with protective film which shall remain on the signs until installation is complete.
- B. Signs shall not be shipped loose. All signs shall be properly crated and secured for shipment. Avoid strapping signs in such a manner that may result in abrasions.
- C. Defective materials resulting from improper shipment, storage and handling shall be rejected by the Owner.
- D. The contractor shall plan shipments so as to not interfere with Owner's business operations or site construction.
- E. Identify a storage area prior to shipment that is agreed to by Owner and/or General Contractor.
 - 1. Provide adequate barricades to protect the stored materials. Lighted barricades shall be utilized if stored in drive areas on Owner's property.

1.6 WARRANTY

- A. Manufacturer's shall provide the minimum warranty requirements noted below:

Fluorescent Lamps: 1 Year

Fluorescent Ballasts – Parts: 1 Year

Fluorescent Ballasts – Labor: 2 Years

Lamp Sockets & Wiring – Material: 1 Year

Lamp Sockets & Wiring – Labor: 1 Year

Exterior Paint Finishes: 10 Years

Polycarbonate Faces - fading/yellowing/light transmission: 12 Years

Polycarbonate Faces - Breakage due to mfgs. Defect: 12 Years

3-M 3630 Series Vinyl 2nd surface (vertical) applied to solar grade
poly: 10 Years

3-M 3630 Series Southwest Area: 6 Years

Digitally Printed vinyl applied to 2nd surface: 5 Years

Manufacturer's Workmanship: 1 Year

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. The following manufacturers are approved by Owner for fabrication and installation of exterior signs:
 - 1. Fairmont Sign Company. Contact Tom Homeier @ 216-642-0044
 - 2. Federal-Heath Sign Company. Contact Matt Smith @ 770-992-9060 ext. 212
 - 3. The ICON Companies. Contact Laura Monroe @ 865-805-6001

2.0 MATERIALS

- A. 3M Translucent Vinyl
- B. 3M Opague Vinyl
- C. .090 Aluminum – sign can

- D. Akzo Nobel Paint products
- E. Pre-finished ACM metal panels by Alpolic or approved equal.
- F. Brackets and Mounting Frame.
- G. Lifting Brackets (if required)
- H. Anchors, thru-bolts, anchor bolts, etc.
- I. Bumper posts (if required)
- J. Sealants
- K. Polycarbonate sign product
- L. Digital print vinyl application
- M. Electrical components:
 - 1. T-12 – Daylight – High Output lamps
 - 2. Advance electronic ballasts

2.2 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.3 FABRICATION

- A. General: Provide manufacturer's standard signs based on configurations indicated in Owner drawings and/or renderings and standard design manual.
- B. Manufacturer's shop drawings must be approved by Owner with Notice to Proceed (Purchase Order) prior to fabrication.

2.4 PREPARATION

- A. Remove and dispose of any existing signs off-site. Check with Owner if the signs are to be salvaged or destroyed.
- B. A simulated flag test may be required to pinpoint the exact positioning prior to installing the free-standing sign. Contact Owner to confirm whether this will be required prior to installation.

2.4 FINISHES, GENERAL

- A. Signs are to be secured in a suitable crate prior to shipping.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with Owner's and manufacturer's written instructions. Do not install signs until all surface finishes are satisfactorily complete.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
 - 1. Exterior Fascia Signs shall be **thru-bolted** as noted on Manufacturer's engineering drawings. If this is not possible due to building design characteristics, the sign shall be securely fastened with suitably sized and spaced hurricane bolts and anchors as recommended by the manufacturer.
 - 2. Light weight signs: Use non-removable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended by sign manufacturer.
- C. Free-standing sign posts are not to be a direct-bury installation. A foundation of suitable size as designed by the manufacturer or his engineer shall be installed, complete with rebar and above grade anchor bolts. The top of the concrete base shall be installed in a Sonotube form 6" above the grade level.
- D. All exterior illuminated signs shall be wired in combination with a mechanical timer and adjustable photocell. Locate the photocell on the North side of the building.
 - 1. During daylight hours, the photo cell will override the time clock and turn **all** of the signs off. Adjust the photocell to switch signs on when weather is cloudy and overcast.
 - 2. Set the timer to turn signs off at 11:00pm and turn signs on at 5:00am.

3.2 ADJUSTING AND CLEANING

- A. After installation, clean soiled sign surfaces with non-abrasive dishwashing liquid and water per manufacturer's instructions. Protect signs from damage until acceptance by Owner.
- B. Remove debris created by sign installation, including bolts, screws, excavated debris, caulking tubes, etc.
- C. Repair disturbed areas in grass and drive areas to previous condition.
- D. Remove Sonotube foundation form and parge concrete if necessary.
- E. Evaluate signs at night for proper illumination.
 - 1. Eliminate any hot spots by adjusting light fixture positions.
 - 2. Correct any areas where light emits through faces and/or cabinets.
 - 3. Determine proper function of photocell and timer. Adjust as needed.
- F. Protect signs from damage until acceptance by Owner.

SECTION 10440 – NON-ILLUMINATED PANEL SIGNS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Non-illuminated panel signs shall be furnished by Owner and installed by the Contractor.
- B. This Section includes the following:
 - 1. Panel signs.
- C. Related Sections include the following:
 - 1. Division 22 Section "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
 - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
 - 3. Division 26 Sections for electrical service and connections for illuminated signs.
 - 4. Division 26 Section "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
 - 5. Division 26 Section "Interior Lighting" for illuminated Exit signs.

1.2 DEFINITIONS

- A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.3 SUBMITTALS

- A. Product Data: Furnished by Owner's vendor for each type of product Indicated.
- B. Shop Drawings: Provided by Owner's vendor. Show fabrication and installation details for signs.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 PRODUCTS**2.0 MATERIALS**

- A. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

2.1 PANEL SIGNS

- A. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:
 - 1. Acrylic Sheet: 0.080 inch thick.
 - 2. Laminated Sheet: High-pressure engraved stock with face laminated to acrylic core as selected by Owner from manufacturer's full range.
 - 3. Laminated, Etched Photopolymer: Raised graphics with Braille 1/32 inch above surface with contrasting colors as selected by Owner from manufacturer's full range and laminated to acrylic back.
 - 4. Edge Condition: Square cut.
 - 5. Corner Condition: Square.
 - 6. Mounting: Framed.
 - a. Wall mounted with concealed anchors.
 - b. Manufacturer's standard anchors for substrates encountered.
 - 7. Color: As selected by Owner from manufacturer's full range.
 - 8. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch above surface with contrasting colors.
- C. Panel Sign Frames:
 - 1. Acrylic Plastic:
 - a. Color: As selected by Owner from manufacturer's full range.
 - b. Profile: Square.
 - c. Corner Condition: Square.
 - d. Mounting: Wall mounted with concealed anchors.
- D. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
 - 1. Panel Material: Opaque acrylic sheet.
 - 2. Raised-Copy Thickness: Not less than 1/32 inch.
- E. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for three years for application intended.
 - 1. Color: As selected by Owner from manufacturer's full range.
- F. Panel Sign Schedule:
 - 1. Sign Type: Toilet Rooms
 - a. Sign Size: 8" x 8"
 - b. Background Finish/Color: As selected by Owner from manufacturer's full range
 - c. Panel Sign/Frame: Cast acrylic sheet
 - 1) Finish/Color: As selected by Owner from manufacturer's full range.
 - d. Text/Message: Fixed.
 - 1) Character Size: According to ADA requirements or of authorities having jurisdiction, which ever requirements are more stringent.
 - 2) Character Finish/Color: As selected by Owner from manufacturer's full range.
 - 3) Copy: Raised
 - 4) Text: According to ADA requirements or of authorities having jurisdiction, which ever requirements are more stringent.
 - 5) Character Style: Helvetica
 - 2. Sign Type: Room Identification
 - a. Sign Size: 3" x 6 "
 - b. Background Finish/Color: As selected by Owner from manufacturer's full range
 - c. Panel Sign/Frame: Cast acrylic sheet
 - 1) Finish/Color: As selected by Owner from manufacturer's full range.

- d. Text/Message: Fixed.
 - 1) Character Size: According to ADA requirements or of authorities having jurisdiction, which ever requirements are more stringent.
 - 2) Character Finish/Color: As selected by Owner from manufacturer's full range.
 - 3) Copy: Tactile and Braille
 - 4) Text: Room name.
 - 5) Character Style: Helvetica
- 3. Sign Type: Occupancy
 - a. Sign Size: 3" x 12"
 - b. Background Finish/Color: As selected by Owner from manufacturer's full range
 - c. Panel Sign/Frame: Cast acrylic sheet
 - 1) Finish/Color: As selected by Owner from manufacturer's full range.
 - d. Text/Message: Fixed.
 - 1) Character Size: According to ADA requirements or of authorities having jurisdiction, which ever requirements are more stringent.
 - 2) Character Finish/Color: As selected by Owner from manufacturer's full range.
 - 3) Copy: Tactile and Braille
 - 4) Text: Maximum occupancy load
 - 5) Character Style: Helvetica
- 4. Sign Type: Accessible Entrance
 - a. Sign Size: 4 1/2" x 4 1/2"
 - b. Background Finish/Color: As selected by Owner from manufacturer's full range
 - c. Panel Sign/Frame: Cast acrylic sheet
 - 1) Finish/Color: As selected by Owner from manufacturer's full range.
 - d. Text/Message: Fixed.
 - 1) Character Size: According to ADA requirements or of authorities having jurisdiction, which ever requirements are more stringent.
 - 2) Character Finish/Color: As selected by Owner from manufacturer's full range.
 - 3) Copy: Tactile and Braille
 - 4) Text: Maximum occupancy load
 - 5) Character Style: Helvetica

2.2 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.3 FABRICATION

- A. General: Provide manufacturer's standard signs of configurations indicated.

2.4 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other

components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy, background, and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for three years for application intended.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions. Do not install signs until all surface finishes are satisfactorily complete.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Interior Wall Signs:
 - a. Install directional signs on walls adjacent to latch side of door where applicable. Where not possible, such as double doors, install signs on nearest adjacent walls and locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
 - b. Install menu-boards as indicated on Owner's schematic and anchor securely at a minimum of 32" horizontally and 24" vertically. Anchors are to be concealed behind menu-board flange cover.
 - c. Warning signs shall be installed in locations directed by Owner's representative.
 - 3. Exterior Wall Signs, such as snap frames, shall be installed as directed by Owner's representative.
- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
 - 1. Silicone-Adhesive Mounting: Attach signs to irregular, porous, or vinyl-covered surfaces.
 - 2. Mechanical Fasteners: Use non-removable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended by sign manufacturer.

3.2 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

SECTION 10505 – METAL LOCKERS

PART 1 – GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 of the Specifications apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Metal lockers.
 - 2. Provide blocking, fasteners and anchorage devices to install lockers provided under this section.
 - 3. Provide metal filler panels to fill between banks of lockers and adjacent construction.

1.2 QUALITY ASSURANCE

- A. Installers Qualifications: Lockers to be installed by an experienced installer.

PART 2 – PRODUCTS

2.0 MANUFACTURERS

- A. Lockers provided by Owner and installed by G.C.

PART 3- EXECUTION

3.0 INSTALLATION

- A. All lockers securely anchored to wall and base with approved fastenings. Fastenings applied shall be through suitable reinforcing plates.

3.1 ADJUSTING

- A. General Requirements: Upon completion of installation, inspect lockers and adjust for proper door and locking mechanism operation.

3.2 CLEANING

- A. General Requirements
 - 1. Clean interior and exposed exterior surfaces, removing debris, dust, dirt, and foreign substances on exposed surfaces.
 - 2. Touch up scratches and abrasions to match original finish.
 - 3. Polish stainless steel and non-ferrous metal surfaces
 - 4. Replace locker units that cannot be restored to factory-finished appearance.
 - 5. Use only materials and procedures recommended or furnished by locker manufacturer.

SECTION 10522 - FIRE EXTINGUISHERS**PART 1 GENERAL****1.0 WORK INCLUDED**

- A. Fire Extinguishers
- B. Accessories

1.1 RELATED WORK

- A. Section 06100 - Rough Carpentry: Roughed-in wall openings.
- B. Section 09250 - Gypsum Wallboard
- C. Section 09920 – Interior Paint

1.2 REFERENCES

- A. NFPA 10 - Portable Fire Extinguishers.

1.3 QUALITY ASSURANCE

- A. Conform to NFPA 10 requirements for extinguishers. The Owner shall be responsible for fire extinguishers to be maintained by a qualified, bonded fire extinguisher company or person on an annual basis. Each extinguisher shall have a tag or label securely attached indicating the date and person performing the maintenance.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 01340.
- B. Include physical dimensions, operational features, color and finish, wall mounting brackets with mounted measurements, anchorage details, rough-in measurements, location, and details.
- C. Submit manufacturer's installation instructions under provisions of Section 01340.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not install extinguishers when ambient temperatures may cause freezing.

PART 2 PRODUCTS**2.0 MANUFACTURERS**

- A. AMEREX
- B. J.L. Industries
- C. Larsen's Manufacturing Company
- D. Substitutions: Under provisions of Section 01600.

2.1 MATERIALS

- A. Upper Service Area: 4A-60BC – Minimum 2 required. Refer to drawings.
- B. Lower Service Area: 4A-60BC – Minimum 2 required. Refer to drawings.
- C. Finishes: Red enamel

PART 3 EXECUTION

3.0 INSPECTION

- A. Ensure suitable means of support prior to installation.
- B. Beginning of installation means acceptance of existing conditions.

3.1 INSTALLATION

- A. Secure brackets rigidly in place in accordance with manufacturer's instructions. Recess cabinets (if applicable) into walls. Install bottom of cabinets 42" above floor.

SECTION 10810 - TOILET ACCESSORIES**PART 1- GENERAL****1.0 SECTION INCLUDES**

- A. Toilet and washroom accessories.

1.1 RELATED SECTIONS

- A. Section 06100: Placement of concealed wood blocking.

1.2 QUALITY ASSURANCE

- A. Conform to Americans with Disabilities Act for installing work.

1.3 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Grabbar Warranty: manufacturer's standard form in which manufacturer agrees to replace defects such as rust that fail in materials or workmanship within specified warranty period.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2- PRODUCTS**2.0 MATERIALS**

- A. The Contractor shall provide and install the following toilet accessories as manufactured by Bobrick at the locations and heights shown on the drawings and as required by local handicap codes. Bradley (Universal Manufacturing Co.) is an acceptable alternative manufacturer. Contact for Corporate Express is Michele Bartel @ 513-870-8606.
 - 1. Grab bars
 - 2. Coat hooks
 - 3. Paper holders
 - 4. Customer Restroom Soap dispenser
 - 5. Employee Restroom Soap dispenser
 - 6. Paper Towel Dispenser
 - 7. Mirror
 - 8. Mop Holder
- B. Sheet Steel: ANSI/ASTM A366.
- C. Stainless Steel Sheet: ASTM A167, Type 304.
- D. Adhesive: Contact type, waterproof.
- E. Fasteners, Screws, and Bolts: Hot-dipped galvanized steel, tamper-proof type.

2.1 UNDERLAVATORY GUARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Plumberex Specialty Products, Inc.
 - 2. TCI Products.

3. Truebro, Inc.
- B. Under-Lavatory Guard:
 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping, and allow service access without removing coverings.
 2. Material and Finish: Antimicrobial, molded-plastic, white.

2.2 FABRICATION

- A. Form surfaces flat without distortion. Weld and grind joints smooth.
- B. Shop assemble components and package with anchors and fittings.
- C. Back paint components to prevent electrolysis.
- D. Provide steel anchor plates, adapters, and anchor components for installation.

2.3 FINISHES

- A. Anchors: Galvanize to 1/25 oz./sq yd.
- B. Chrome/Nickel Plating: ASTM B456, Type SC 2; satin finish.
- C. Stainless Steel: No. 4 satin luster finish.
- D. Under lavatory guards: White

PART 3- EXECUTION

3.0 EXAMINATION AND PREPARATION

- A. Verify exact location of accessories for installation.
- B. Deliver inserts and rough-in frames to site. Provide templates and rough-in measurements as required.
- C. Provide 1 1/2" solid blocking in stud walls and 3/4" PPT solid blocking in furred spaced of masonry walls for attachment of toilet accessories.
- D. Contractor is advised that the toilet room hardware is a special item and must be ordered early since there may be a lengthy delivery time.

3.1 INSTALLATION

- A. Install fixtures, accessories and items in accordance with manufacturer's instructions.
- B. Install plumb and level, securely and rigidly anchored to substrate blocking.
- C. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

SECTION 11132 – TIRE ROTATION LIFTS**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

DEFINITION

- A. Surface mount and recessed low-rise hydraulic and bladder type tire rotation lifts designed for light duty vehicles.

1.2 REFERENCES

- A. The installation of equipment shall comply with the standards referred to in ASME/ANSI MH 14.1 except where they conflict with requirements of these specifications.

1.3 RELATED WORK

- A. Cast-In-Place Concrete: Section 03300.
- B. Division 22 Plumbing
- C. Division 26 Electrical
- D. Section 07900 - Joint Sealants

1.4 SUBMITTALS

- A. Shop Drawings (if requested by Owner): Submit fabrication details and connections to structure for the lift equipment. Include the following:
 - 1. General layout of installation, showing reaction points with reactions.
- B. Product Data (if requested by Owner): Catalog sheets, specifications, and installation instructions.
- C. Contract Closeout Submittals:
 - 1. Full load test report.
 - 2. Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.

1.5 QUALITY ASSURANCE

- A. Installers shall be skilled with lift and hoist installations and have at least 5 years experience.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Protection:
 - 1. Protect equipment and exposed finishes during transportation and erection against damage.
 - 2. Protect exposed equipment, power unit, hydraulic ram, control button, oil reservoir from all foreign material during course of construction.

1.7 WARRANTY

- A. The manufacturer shall warrant the structural components of the Tire Rotation Lift to be free from defects in material and workmanship under normal use for a period of two years from invoice date.

PART 2 PRODUCTS**2.0 TIRE ROTATION LIFT MANUFACTURERS**

- A. Acceptable Manufacturers:
 - 1. Norco Industries Inc. 800-347-2232

2.1 PRODUCT REQUIREMENTS

- A. Equipment Requirements – Norco 79342G W/VIOC Accessories:
- B. Anchors:
 - 1. All necessary bearing plates and shims as required to adequately secure lift and ramps to pit floor including:
 - a. Thru-bolts
 - b. Double nuts with Grip-Tite application
 - c. 1/4" x 4" x 4" anchor plate on bottom-side
- C. Platform:
 - 1. Platform floor of 1/4 inch minimum steel plate with anti-slip ramp surface.
- D. Bearings: All pivot points and rollers shall be equipped with grease fittings and anti-friction bearings.
- E. Safety Devices:
 - 1. Means shall also be provided to lock the lift in place in raised position.
 - 2. The maximum load rating capacity shall be clearly noted on the power unit and lift assembly.
- F. Accessories:
 - 1. All necessary hoses and fittings required to connect power unit to lift, safety rated per manufacturer's requirements.
 - 2. Vehicle Stop Plates – Painted Safety Yellow.

2.2 RACEWAYS FOR HYDRAULIC FLEXIBLE HOSE INSTALLATION

- A. Rigid Nonmetallic Pipe, Fittings and Accessories: Carlon's Plus 40, Certain Teed Corp.'s Schedule 40, National Pipe & Co.'s Schedule 40, Queen City Plastics Inc.'s Schedule 40, or Sedco Pipe Products' Schedule 40.

PART 3 EXECUTION**EXAMINATION**

- A. Prior to installation, the contractor shall confirm with Owner that the floor is structurally suitable to handle the maximum load capacity. Owner shall arrange for any required structural remedies (if required) prior to installation.
- B. If the lift is a recessed unit, confirm that cut-out is correctly dimensioned and located. Advise Owner of any discrepancies.
- C. Coordinate location and installation of pipe raceway for installation of the hydraulic flexible hose from machine area to pit.
- D. If pre-cast floor, locate anchor position to avoid drilling into tendons.
- E. Determine location of lift control unit (if not indicated on drawings). Locate so as to allow operator to visually see the lift locking mechanism is engaged.
- F. There should be adequate space on all sides of the lift. Note that the lift and vehicle will move approximately 14" backward as the lift rises to its full height.
- G. Position lifts so that the front of vehicle in a raised position is not more than 4" beyond the covered floor area. For bladder controlled lifts, consider placement with understanding that the engine of the vehicle must be placed over the air bag portion of the lift.

3.1 GENERAL INSTALLATION

- A. Install leveler unit at location shown on the drawing. Mount bed plate frame to concrete slab.
- B. Install lift unit in accordance with the manufacturer's printed instructions.
- C. The bases must be aligned perfectly and the same distance apart.
- D. Shim as required to level both sides of the lift. Note: It is recommended that non-shrinking grout or some other solid material be placed under the lifts to ensure that no bending or warping takes place between shims.
- E. If installing above an open pit area, the unit must be thru-bolted. Consult manufacturer on anchoring requirements.
 - a. Utilize a method for drilling through the pre-cast or concrete floor that does not blow out the concrete.
 - b. Thru-bolts must be sealed along the top with Sika product Sikaflex 1-a Polyurethane black sealant to prevent moisture penetration.
- F. Place control pedestal in desired location and securely anchor to floor. Note: the unit must be positioned to allow full visibility by operator of the Safety Latchet Locking Mechanism. Seal around base of pedestal with Sika product Sikaflex 1-a Polyurethane black sealant to prevent moisture penetration.
- G. Air and electrical connections shall be in accordance with manufacturer and regulatory requirements.
- H. Lubricate grease fittings and all moving parts per manufacturer's instructions.
- I. Install safety decals provided with equipment.

3.2 TESTING AND ADJUSTMENT

- A. Tests: Supply all materials, personnel, instruments etc. required for testing of equipment.
 - 1. Perform a full load test ascertaining the lift makes smooth, level and accurate starts and stops.
 - 2. Ensure Safety Latchet Locking Mechanism engages and disengages properly.
 - 3. Ensure safety features (ie. pressure relief valves) operate properly.
 - 4. Ensure all hydraulic and air lines are tight.
 - 6. Bleed all air from hydraulic lines and ensure reservoir is filled.
 - 7. Test anchor penetrations to ensure moisture does not penetrate.
- B. Perform final tests in presence of Owner's Representative.

3.3 CLEANING

- A. Remove all debris resulting from the installation. Clean up all concrete dust resulting from drilling for anchors. Remove all dirt, smudges, fluids, etc. resulting from the installation.

SECTION 11146 – LUBRICATION EQUIPMENT**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. The lubrication system shall be furnished and installed by Owner hired contractor.
- B. This Section includes the following:
 - 1. Piping and accessories for the installation of lubrication system.
- C. Related Sections include the following:
 - 1. Division 22 Plumbing
 - 2. Division 11 Above-Ground Tanks

1.2 SUBMITTALS

- A. Product Data: Furnished by Owner's vendor for each type of product indicated.
- B. Shop Drawings: Provided by Owner's vendor. Show fabrication and installation details for each product and air supply.
 - 1. Indicate type pump
 - 2. Indicate the type metered gun for each product.
 - 3. Indicate various system components; valves, filters, hoses, etc.
 - 5. Provide equipment data sheets along with trouble-shooting guides and maintenance recommendations.
- C. Certification: Equipment meets UL and regulatory approval.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. U.L. 142, Underwriters Laboratories, Inc., Steel Aboveground Tanks for Flammable and Combustible Liquids.
 - 2. NFPA 30, National Fire Protection Association Flammable and Combustible Liquids Code.
 - 3. NFPA 30A, National Fire Protection Association Automotive and Marine Service Station Code.
 - 4. Uniform Fire Code, International Fire Code Institute.
 - 5. PEI/RP200- Petroleum Equipment Institute, Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling.
 - 6. An installer certified by the manufacturer.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.
- B. The General Contractor shall not arrange to install the Lubrication System until the facility is under roof and doors and windows are installed and can be locked.

1.5 WARRANTY

- A. Manufacturer's Conditional Warranty is five years on equipment from date of completed installation.

PART 2 PRODUCTS

2.0 MANUFACTURERS

- A. Alemite, LLC. Contact 800-233-0400
- B. Champion Compressed Air Piping. Contact Vince Eichhorn 405-473-1220 or Devon 800-468-1970

2.1 MATERIALS

- A. Product Lines: High Pressure fully annealed Seamless Steel Tubing.
 - 1. Steel Tubing is designated by its outside diameter (OD) and its wall thickness. While it is available in a wide range of sizes (3/8 in, 1/2 in, 5/8 in, 7/8 in, and 1 in OD) tubes are quite commonly used as fluid lines. Choice of wall thickness is practically unlimited and is governed by the working pressures encountered. Wall Thickness of Tubing .025 in .028 in .032 in .035 in .042 in .049 in .058 in .065 in .072 in .083 in .095 in .109 in .125 in
- B. The chart below lists general tubing selection guidelines for specified pumps. Each application varies and should be carefully considered for special conditions that may require a tubing selection other than the standard recommendations listed. These conditions include, but are not limited to:
 - 1. Viscosity of product pumped
 - 2. Ambient temperature conditions
 - 3. Simultaneous operation of several dispensing outlets
 - 4. Dispensing volume requirements
 - 5. When measuring total piping distance, the hose length at dispensing guns should be included in total distance.

a.	HIGH PRESSURE GREASE PUMP: PIPING RUNS 0 – 75'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	50:1	5/8"	.083"
b.	HIGH PRESSURE GREASE PUMP: PIPING RUNS 75' – 150'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	50:1	3/4"	.095"
c.	HIGH PRESSURE GREASE PUMP: PIPING RUNS - OVER 150'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	50:1	1"	.125"
d.	MEDIUM PRESSURE OIL PUMP: PIPING RUNS 0 – 200'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	3:1	5/8"	.035"
e.	MEDIUM PRESSURE OIL PUMP: PIPING RUNS - OVER 200'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	3:1	1"	.049"
f.	MEDIUM PRESSURE OIL PUMP: PIPING RUNS 0 – 200'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	5:1	5/8"	.035"
g.	MEDIUM PRESSURE OIL PUMP: PIPING RUNS - OVER 200'		
	Pump Ratio	Tubing Pipe OD.	Tubing Wall Size
	5:1	1"	.049"
- C. Air Lines – Aluminum Piping Color Blue
 - 1. Main Distribution Branch Line – 3/4"
 - 2. Branch Lines – 3/4"
- D. Evacuation Line
 - 1. 1" Black steel pipe
- E. Hose
 - 1. Oil Delivery Hose: 1/2" ID x 15'. 1/2" MxF

2. Oil Connecting Hose: 1/2" ID x 5'. 1/2" MxF
 3. Chassis Connecting Hose: 1/4" ID x 5'. 3/8" MBE
 4. Grease Supply Hose: 1/4" ID X 20'. 1/2" – 27 NS(F)
- F. All piping furnished and installed by installer.

2.2 ACCESSORIES

- A. Pumps
- B. Control Valves
- C. Tanks
- D. Air Compressor
- E. Fluid Gauges
- F. Filters
- G. Moisture Separators
- H. Drip Pans
- I. Valve Console
- J. Mounting Brackets
- K. Regulator
- L. Camlock Coupler
- M. Strainers
- N. Bibbs
- O. Holster
- P. Hose guide
- Q. Valves
- R. Miscellaneous pipe fittings
- S. Dryer (Model number CGD25A)

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. General
 1. Always use new pipe. Make certain that pipes are clean and free of rust and scale.
 2. When cutting pipe remove burrs and chips that may damage dispense valves and meters.
 3. Do not use Teflon Tape or pipe sealant on fluid and equipment threads.
 4. Install oil product pumps on topside of tanks unless there are overhead space limitations.
 5. Do not use dissimilar metal materials when anchoring piping.
 6. Minimize the number of Elbows which can reduce pressure drop. Use radius bends in preference to Elbows where installation permits.
 7. Install all piping neatly and in the same plane.
 8. Do not bore holes in pre-cast flooring without Owner and Owner's General Contractor approval.
 9. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
 10. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

11. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
 12. Install equipment to allow right of way for piping installed at required slope.
 13. Mount pumps, tubing, etc. in a manner that limits movement during use.
 14. Fluid and air connections to pumps and reels must be made with a flexible hose, 18" minimum.
 14. Coordinate locations with all other trades before installing.
 15. Drawing plans, schematics, and diagrams indicate general location and arrangement of equipment and piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout necessitate a required change.
- B. Air
1. Install Owner furnished air compressor complete with S&S Un-loader, low oil level switch, 3/4" Ball Valve, four (4) vibration mounts, muffler, 1/4" drain valve, mag starter and pressure gauge.
 2. A 3/4" supply line shall be installed in a loop system with 1/2" air supply feeds to each pump provided positioned above the main distribution line and never in series. An 8" long moisture drop w/ ball valve for blow-off of moisture build-up shall be provided at each supply.
 3. The air distribution line shall slope continuously in direction of air flow.
- C. Product
1. When thermal expansion of oil may be present, use a pump pressure relief valve.
 2. Regulate air supply pressure to each pump as required to properly operate in accordance with manufacturer's requirements.
 3. Prior to attaching dispensing control valves, flush oil and grease lines with a cleaning solution followed by compressed air. Once this is complete, flush the system with oil before attaching control valves and meters.
 4. Remove and clean strainer screens and filters.

3.2 TESTING

- A. Aboveground storage tanks for flammable and combustible liquids are pre-tested by the manufacturer in accordance with the requirements of the underwriter's laboratories standard UL 142.
1. The Owner's installer shall successfully complete an air pressure test of 3-5 psi prior to installation of the piping system in accordance with manufacturer's recommendations but not less than 2 hours.
 - a. Utilize a soap solution and brush over weld seams and all tank bungs. Inspect tank contents before filling and replace tin caps with pipe plugs or doped piping before test.
 - b. When testing a double wall tank, the inner tank should be pressurized to a maximum capacity of the outer tank by bringing the pressure up very slowly to 3-5 p.s.i. Maximum capacity of the outer tank is very small in relation to the primary tank capacity. Compressors used for testing can over pressurize the outer tank space in seconds causing serious damage to the tank.
- B. Product, air and water lines shall be air tested at intended operating pressure for a period of 2 hours. **DO NOT** subject tanks to this pressure. Risk of rupture is probable.
- C. Owner's representative shall be contacted by the installer prior to the tests to arrange for test inspections.
- D. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
- E. Some equipment is capable of producing high pressure. Misuse or misapplication of this equipment can cause component rupture, fire or explosion and result in serious bodily injury, including fluid injection or splashing in the eyes or on the skin. **Never** exceed the

- maximum working pressure of the lowest-rated component in the system. See the instruction manual included with the equipment for more detailed information.
- F. Conduct metered tests of each product in accordance with manufacturer's recommendations, regulatory requirements and PEI-RP200.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled tank, piping and equipment surfaces according to manufacturer's instructions. Protect tanks and Lubrication System from damage until acceptance by Owner.

SECTION 11147 – ABOVE-GROUND TANKS**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Above ground tanks shall be furnished by Owner and installed by the Contractor.
- B. This Section includes the following:
 - 1. Single Wall Above-Ground Tanks
 - 2. Double Wall Above-Ground Tanks
- C. Related Sections include the following:
 - 1. Division 22 Plumbing
 - 2. Division 11 Section Lubrication Equipment
 - 3. Division 9 Painting.

1.2 SUBMITTALS

- A. Product Data: Furnished by Owner's vendor for each type of product indicated.
- B. Shop Drawings: Provided by Owner's vendor. Show fabrication and installation details for each size tank.
 - 1. Indicate bung size and location.
 - 2. Indicate lifting lug
 - 3. For double walled tanks, indicate cross section.
 - 4. For compartmentalized tanks, indicate cross section.
 - 5. Provide tank charts for each tank.
- C. Drawing Approval: Contractor shall receive drawing approval prior to product fabrication.
- D. Catalog Data: Contractor shall submit 1 current copy of the manufacturer's literature.
- E. Certification: Each tank shall bear the U.L. 142 label for aboveground liquid storage.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. U.L. 142, Underwriters Laboratories, Inc., Steel Aboveground Tanks for Flammable and Combustible Liquids.
 - 2. NFPA 30, National Fire Protection Association Flammable and Combustible Liquids Code.
 - 3. NFPA 30A, National Fire Protection Association Automotive and Marine Service Station Code.
 - 4. Uniform Fire Code, International Fire Code Institute.
 - 5. PEI/RP200- Petroleum Equipment Institute, Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling.

1.4 PROJECT CONDITIONS

- A. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings. The General Contractor shall arrange to install the tanks in the pit following the placement of the basement floor preferably at the time Pre-cast planks are set in place.

PART 2 PRODUCTS**2.0 MANUFACTURERS**

- A. Modern Welding Company of Kentucky, Inc. located in Elizabethtown, KY.: (270) 769-1368. Subsidiaries include:
 - 1. Modern Welding Company of Owensboro, Inc.
Owensboro, KY (270) 683-5323
 - 2. Modern Welding Company of Ohio, Inc.
Newark, OH (740) 344-9425
 - 3. Modern Welding Company of Florida, Inc.
Orlando FL (407) 843-1270
 - 4. Modern Welding Company of Texas, Inc.
Houston, TX (713) 675-4211
 - 5. Modern Welding Company of Texas, Inc.
Rhome, TX (817) 636-2215
 - 6. Modern Welding Company of Iowa, Inc.
Burlington, IA (319) 754-6577
 - 7. Modern Welding Company of California, Inc.
Fresno, CA (559) 275-9353
 - 8. Modern Welding Company of Georgia, Inc.
Augusta, GA (706) 722-3411
- B. Highland Tank: Stoystown, PA; Manheim, PA; Watervliet, NY; or Greensboro, NC.

2.1 MATERIALS

- A. Steel:
 - 1. Only new material shall be used in the manufacturing process, and the manufacturer shall ensure that the material used meets all appropriate specifications and quality assurance requirements. 1,000 gallon: Single and Double Walled Tanks shall be of all welded construction, fabricated of 10 gauge mild carbon steel.
 - 2. 500 gallon Single and Double Walled Tanks shall be of all welded construction, fabricated of 12 gauge thick mild carbon steel.
- B. Loading Conditions: Tanks shall meet the following design criteria.
 - 1. Internal Load: Tank(s) shall withstand an air pressure test of 3-5 psi.
 - 2. Tank(s) shall be designed to support accessory equipment such as ladders, pumps, floating suction, etc. when installed according to manufacturer's instructions.
 - 3. Tank(s) shall be provided with suitably designed and located lifting lugs which have a 2:1 safety factor.
- C. Product Storage Requirements
 - 1. Single Wall Tank(s) shall be capable of storing liquids with a specific gravity up to 1.0.
 - 2. Double wall tanks shall be capable of storing liquids with a specific gravity up to 1.1.
 - 3. Tank(s) is designed for operation at atmospheric pressure only. Tank(s) shall have openings of sufficient size to meet normal and emergency venting requirements stated in U.L. 142, UFC, and NFPA 30.
- D. Tank(s) shall be capable of storing gasoline, gasohol, jet fuel, avgas, diesel fuel or methanol at ambient temperature or used for fuel oil at temperatures not to exceed 120 degrees Fahrenheit.
- E. Tank shall conform to and be labeled in accordance with Underwriters Laboratories Standard UL-142 type S for single-wall and double-wall tanks.

2.02 ACCESSORIES

- A. Certification Plate: Underwriters Laboratories label shall be affixed to each tank.
- B. Fittings: Threaded/NPT
 - 1. All threaded fittings shall be of a material of construction consistent with the requirements of the Underwriters Laboratories label. All fittings shall be protected using threaded plugs or suitable closure caps.
 - 2. Location: Refer to drawings.
- C. Supports:

1. Design and quantity of the steel supports shall be such as to safely support the weight of the tank filled to capacity.
 - a. Height of supports: 2".

2.3 FABRICATION

- A. Standard construction shall utilize lap joints with continuous fillet weld on all outside seams only.
- B. Tank shall include five 2" forged steel fittings and one 4" or 6" forged steel emergency vent fitting for each tank wall. Two 2" forged fittings shall also be provided; at the bottom of each corner on one side of the tank.
- C. Fabrication shall include 2" high supports welded to the tank underside, providing ground clearance for visual inspection.
- D. Dimensional Requirements
 1. Single Wall Tanks:
 - a. 500 gallon: 5'0" long x 2'8" wide x 5'0" high
 - b. 1,000 gallon: 10'0" long x 2'8" wide x 5'0" high
 2. Double Wall Tanks:
 - a. 500 gallon: 5'1-1/2" long a 2'8-1/2" wide x 5'1/2" tall
 - b. 1000 gallon: 10'1-1/2" long a 2'8-1/2" wide x 5'1/2" tall
- E. Finish: Sherwin Williams Dura-Plate 235 self priming epoxy
 1. Color – Safety Red.
 2. Perform Holiday test to ensure no surface coating imperfections.

PART 3 **EXECUTION**

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Tank shall be installed in strict accordance with the most recent installation instructions provided by the tank manufacturer, PEI/RP200, UFC, NFPA 30, local ordinance, recognized engineering procedure, and other applicable codes.
- B. Handle tank carefully. Use cables, chains or lifting straps of adequate length (not more than 90 degrees between the chains) attached to lift lugs provided, oversize hooks will tear the lift lugs- use shackles, if necessary.
- C. Install appropriate primary and emergency vent connection as indicated on tank and drawings. The General Contractor is responsible for installation of all tank venting. Do Not manifold Waste Oil tank vent with Product Venting.
- D. Do not cut or weld on any tank that contains flammable or combustible liquids or vapors. Fire or explosion may result.
- E. Contact the local fire marshal to assure compliance with local regulations and codes.
- F. Be sure all drain plugs are secure by applying suitable pipe dope around cast iron plug.
- G. Ensure that tanks are level. Shim with galvanized steel shims as needed.

3.2 TESTING

- A. Aboveground storage tanks for flammable and combustible liquids are pre-tested by the manufacturer in accordance with the requirements of the underwriter's laboratories standard UL 142.

1. The Owner's installer shall successfully complete an air pressure test of 3-5 psi prior to installation of the piping system in accordance with manufacturer's recommendations.
2. Utilize a soap solution and brush over weld seams and all tank bungs. Inspect tank contents before filling and replace tin caps with pipe plugs or doped piping before test.
3. When testing a double wall tank, the inner tank should be pressurized to a maximum capacity of the outer tank by bringing the pressure up very slowly to 3-5 p.s.i. Maximum capacity of the outer tank is very small in relation to the primary tank capacity. Compressors used for testing can over pressurize the outer tank space in seconds causing serious damage to the tank.

3.2 CLEANING AND PROTECTION

- A. After installation, clean soiled tank surfaces according to manufacturer's instructions. Protect tanks from damage until acceptance by Owner.
- B. Do not walk on, stand on or use the tank surface as a working surface.
- C. The General Contractor shall cover tanks with polyethylene until such time that piping is installed.

SECTION 11302 – UNDERGROUND PRE-CAST OIL/WATER SEPARATORS**PART 1: GENERAL****1.0 RELATED DOCUMENTS**

- A. The provisions of the General Conditions, Supplementary Conditions, Sections included under Division 1, General Requirements, and Division 00 of this Division are included as part of this Section as though bound herein.
- B. Refer to details and schedules on the drawings for additional requirements.

1.2 RELATED WORK

- A. Division 31: Earthwork
- B. Division 22: Plumbing
- C. Division 32: Concrete

SUMMARY

- A. The Contractor shall furnish the labor, materials, equipment, appliances, services and hauling, and perform operations in connection with the construction and installation of precast concrete underground oil/water separator and lift sump. Work shall be as herein specified and as denoted on the accompanying Drawings but not limited to the following general terms of work:
 - a. Sanitary sewer
 - b. Manholes
 - c. Concrete Vaults or chambers
 - d. Oil/water separators
 - e. Sump pump
- B. Provide specified oil/water separator tank(s), hold-down straps and anchoring system, manway extension(s), piping and venting for influent and effluent, vent piping and cap for tank, and oil draw-off pump(s) (if necessary) required to make a complete installation ready for use. The oil/water separator shall be pre-packaged, pre-engineered, ready to install unit. The Contractor shall provide filling of tank(s) with clean water. Tanks/anchoring system shall be constructed for non-flotation under full submersion of water. The Contractor shall mechanically unload the oil/water separator at the job site.

GOVERNING STANDARDS

- A. UL 58 Underwriters Laboratories Inc. Steel Underground Tanks for Flammable and Combustible Liquids
- B. UL 1746 Underwriters Laboratories Inc. External Corrosion Protection Systems for Steel Underground Storage Tanks
- C. UL Subject 2215 Underwriters Laboratories Inc. Outline of Investigation for Oil/Water Separators National Fire Protection Association (NFPA 30) Flammable and Combustible Liquids Code, (NFPA 30A) Automotive and Marine Service Station Code, (NFPA 70) National Electric Code. Unified Facilities Guide Specification 13202A (July 2002) Division 13, Special Construction, Fuel Storage Systems.
- D. All tanks and piping shall be properly installed in accordance with the manufacturer's instructions and either Petroleum Equipment Institute (PEI) Recommended Practice RP100, latest edition; Recommended Practice for Installation of Underground Liquid Storage Systems, or American Petroleum Institute (API) Publication 1615-87; Installation of Underground Petroleum Storage Systems.
- E. ASTM Specification D2996, Filament Wound Reinforced Thermosetting Resin in Pipe. EPA Test Method 1664A, Oil and Grease, Recoverable Extraction).

QUALITY ASSURANCE

- A. Test Data: The manufacturer must provide Certificate of Compliance from Underwriters Laboratories proving that the oil/water separator is capable of producing effluent with no more than 15 ppm free oil and grease (not dissolved nor chemically emulsified with soaps or detergents) when tested using the EPA Test Method 1664A. The test inlet oils are a 50/50 mixture per the UL Subject 2215 guidelines. The testing and results will show results for: Test per the UL SU2215 guidelines. The oil/water effluent cannot exceed average of 15 ppm.
- B. Oil/water separator tank shall be pre-cast concrete constructed to meet governing standards with certification plate (UL Label) affixed.
- C. Shop Drawings: Contractor shall submit 4 copies of shop drawings. Drawings shall include all critical dimensions, locations of fittings and accessories, i.e.: manways, hold-down straps, manway extensions, etc.
- D. All OWS tanks, equipment and piping materials shall be physically inspected and tested before being installed. Any defects observed shall be immediately brought to the attention of the Owner. It shall be the sole responsibility of the Contractor to correct any deficiencies, with the manufacturer in strict accordance with manufacturer's recommendations, at no additional cost to the Owner.
- E. Contractor shall submit 4 copies of the manufacturer's literature including 4 copies of manufacturer's current installation instructions to the Owner.
- F. The Installer shall be a state licensed UST installer during the entire duration of the project. The Contractor shall have the responsibility of notifying and coordinating with all local and state officials, including the local Fire Department (where required). The Contractor shall coordinate with the Owner to provide a written site safety plan (where required).
- G. Oil/water separators specified herein will not remove oils with specific gravities greater than 0.95, chemical or physical emulsions, dissolved hydrocarbons, or volatile organic compounds (VOC).
- H. The Contractor shall obtain and pay for all permits, tests, inspections, etc. required by the local boards that have jurisdiction over the project. All work shall be executed and inspected in accordance with all local and state codes, rules, ordinances, or regulations pertaining to the particular work involved. Should any changes in the contract drawings and specifications be required to conform to such ordinances, notify the Owner at time of submitting of bid. After entering into the contract, the Contractor shall be held responsible for the completion of all work necessary for a complete and approved installation without extra expense to the Owner.
- I. The OWS shall be a special purpose factory fabricated unit which is a standard product of a manufacturer regularly engaged in the production of such equipment with similar units operating for a minimum of five years.
- J. All concrete products, in this specification, shall be produced by a concrete manufacturing plant qualified by the national pre-cast concrete association (NPCA) certification program. The manufacturer shall submit proof of certification prior to the start of production. The NPCA plant certification program defines the fundamental requirements for a quality control program for pre-cast concrete plants. The 11 items addressed in this program which must be monitored and compared with industry standards include:
 - 1. Management commitment to produce quality products
 - 2. Completeness of work orders and product drawings
 - 3. Quality of raw materials
 - 4. Quality of forms (product molds)
 - 5. Concrete quality conformance with requirements
 - 6. Placement and consolidation of concrete
 - 7. Product dimensions
 - 8. Positioning of embedded items
 - 9. Curing of concrete
 - 10. Handling, storing and transporting
 - 11. Record keeping
 - 12. Manufacturer shall adhere to applicable ASTM, ACI and AASATO standards.

WARRANTY

- A. Manufacturer shall provide a 30 year warranty on performance of the Oil / Water Separator.

PART 2: PRODUCTS**2.0 ACCEPTABLE MANUFACTURERS**

- A. Manufacturer as noted on Owner's drawings or an approved equal.
1. Manufacturer approved equals must be submitted to Owner for approval at least 3 days prior to bid due date.

2.1 OIL/WATER SEPARATOR TANKS:

- A. Provide single or double wall pre-cast concrete underground oil/water separator tank with fittings and accessories as denoted on the Drawings.
- B. Class I concrete with design strength of 4,500 psi within 28 days. Monolithic construction with exception of baffles.
- C. Loading Conditions: Tank shall meet the following Design Criteria:
1. External Hydrostatic Pressure: Buried in ground with a maximum of three feet of overburden over the top of the tank. The design thickness of the tank shall be based on UL 58 / 1746. If overburden and normal ballast is insufficient to keep tank from floating, provide anchors and straps as recommended by the manufacturer.
 2. Surface Loads: When installed according to manufacturer's installation instructions, finished grade surface shall withstand surface H-20 axle loads (32,000 lbs/axle) without transferring surface loads to separator tank.
 3. Tank shall be designed to support accessory equipment as denoted on plans when installed according to manufacturer's recommendations and limitations.
- D. Tank must be vented at the influent tee, oil/water separator chamber or manway(s).
- E. Tank shall be capable of storing liquids with specific gravity of up to 1.0.
- F. Tank shall be capable of storing grease and oils at temperatures not to exceed 100 degrees Fahrenheit at the internal tank surface.
- G. Tanks shall be chemically inert to petroleum products.
- H. Threaded fittings on UL labeled tanks shall be of a material of construction consistent with the requirements of the UL label. Fittings to be supplied with thread protectors. See contract drawings for size and locations of fittings.
- I. Threaded fittings on UL labeled tanks shall have nylon bushings installed for isolation purposes, unless specified piping is PVC or FRP.
- J. Separator shall be equipped with opening/s for waste oil removal and gauging.

2.2 CAPABILITY AND DIMENSIONAL REQUIREMENTS

- A. The following information is dependent on the system design and shall be provided by the Owner prior to project bid:
1. Oil/water separator shall be a single or double wall tank as indicated on drawings.
 2. Flow rate shall be from zero (0) to _____ gallons per minute.
 3. Nominal volume of the separator tank shall be _____ gallons.
 4. The total spill capacity shall be _____ gallons.
 5. The total oil storage capacity shall be _____ gallons.
 6. Emergency oil storage capacity shall be _____ gallons.
 7. Inlet free oil specific gravity shall range from 0.70 to 0.95.
 8. Inlet free oil concentration shall be no more than 200,000 parts per million.
 9. Effluent free oil shall be no greater than _____ parts per million.
 10. Inlet flange diameter shall be _____ inches.
 11. Outlet flange diameter shall be _____ inches.
 12. Nominal overall length of the tank shall be _____ feet.

13. Nominal outside diameter of the separator shall be _____ feet.
14. Operating temperatures of the influent oil/water mixture shall range from 40 degrees Fahrenheit to 120 degrees Fahrenheit.
15. Manway shall be provided with compartment.
16. All manways shall be furnished complete with gaskets, bolts, and covers.
17. Location – See standard tank drawings.

2.3 OIL/WATER SEPARATOR CONTROL SYSTEM (if applicable):

- A. Provide an electronic control panel constructed of UL listed electronic components. The control panel power source is 120 VAC (Contractor provided wiring). The sensor monitoring circuit shall be an intrinsically safe circuit, i.e., the circuit is incapable of releasing sufficient electrical or thermal energy to cause ignition of specific hazardous material under “normal” or “fault” operating conditions.
 1. The model number shall be provided by the oil/water separator manufacturer.
 2. The number of monitoring circuits shall be four.
 3. The electrical components rating shall be weatherproof (NEMA 4).
 4. The dimensions of the control unit are dependent on the amount of controls that are being monitored by the control unit.
 5. The oil interface level sensor(s) are connected at the control panel.
 6. All control panels include:
 - a. Visual alarm(s)
 - b. Audible alarm(s)
 - c. Auxiliary dry contacts switch output for each sensing circuit
 - d. Panel housing materials: Epoxy coated steel, fiberglass, or plastic
 - e. Warning horn silence switch
 - f. Electronics do not require shielded cable. Sensor cable uses #18 AWG (provided by General Contractor)
- B. NOTE: All wiring materials and electrical connections are to be provided by the General Contractor. Wiring is required from the power source to the control panel and from the control panel to the control assembly. Sensor wires must be in a separate conduit from the power wires.

2.4 OIL/WATER INTERFACE FLOAT SENSOR (if applicable):

- A. Provide an Oil/Water Interface Alarm Sensor(s) that is used to determine two separate high waste oil levels in the separator. Level one is to activate at 20% oil and activates a visual alarm. Level two is to activate at 40% oil and activates a visual and audible alarm.
- B. The oil/water interface sensor shall be furnished by the oil/water separator manufacturer.
- C. The Contractor is responsible for finalizing the height of the riser pipe and for contacting the oil/water separator manufacturer with the details so the proper length model can be provided.
- D. First Oil Level Warning Alarm: This alarm warns that the oil/water separator tank is at a high level and the oil will need to be removed soon.
- E. Second Oil Level Warning Alarm: This alarm warns that the oil/water separator tank is at a dangerously high level and the oil will need to be removed immediately.

VENT PIPING

- A. Provide vent materials according to the schedule below. Contractor to use 2-inch FRP or PVC single wall piping.
- B. Vent Cap: 2-inch sch. 40 PVC with turn down elbow at top.
- C. All vents must be separate. Do not manifold with other vent piping.

PIPE MATERIALS:

- A. Provide the following materials as specified on the drawings.

- B. Ductile iron pipe, designated DIP on the drawings, shall be centrifugally cast push on joint ductile iron pipe conforming to ANSI Specification A21.51 with rubber gaskets conforming to ANSI Specification A21.11. Fittings shall be ductile iron conforming to ANSI Specification A21.10. Polyvinyl chloride pipe and fittings, designated SCH 40 PVC on the drawings, shall conform to ASTM D3034.

2.7 LIFT SUMP

- A. If the OWS is located inside the facility, one dual chamber OWS shall be utilized. A sump pump shall be installed on the discharge side of the OWS chamber and piped to the sanitary sewer. The OWS separator shall in no case gravity feed to the sanitary sewer.
- B. If the OWS separator is located outside the building and a single chamber lift sump shall be installed inside the pit area of the building and piped to the OWS in accordance with drawings.
- C. In both situations A. and B. above, the lift sump will be equipped with a sump pump and Constant Pressure Switch provided and installed by the General Contractor as follows:
 - 1. Sump Pump – Zoeller Model N-153 115volt single phase w/ 1-1/2" discharge, 1/2hp vortex impeller capable of handling 3/4" spherical solids (see attached cut sheet). Utilize Zoeller Model 30-0164, 1-1/2" cast iron check valve. In areas where an explosion proof sump pump is required by regulating authorities, the contractor shall utilize a Zoeller NX282 115volt single phase w/ 2" discharge 1/2hp vortex impeller capable of handling 2" spherical solids. Utilize Zoeller Model 30-0152, 2" cast iron check valve
 - 2. Constant Pressure Switch (CPS). A constant pressure switch shall be installed at the discharge side of the OWS chamber. This is designed as means to contain spills and overfills from being discharged directly into the sanitary sewer. The General Contractor shall furnish and install an Allen Bradley model #800T-A601 momentary contact push-button switch in a NEMA Type 4 enclosure Allen Bradley #700T-ITZ. Verify connection requirements. Note: Sump shall not run unless the push button is engaged.

PART 3: EXECUTION

3.0 INSTALLATION

- A. The utmost care must be taken to load/unload, transport and install the pre-cast concrete oil/water separator. Cloth slings, spreader bars and good rigging methods are required for installation. A forklift may be utilized for loading and unloading the separator.
- B. Placement
 - 1. Excavation must provide a minimum of 4" clearance all around the boxes when they are set in place.
 - 2. Use extra care when unloading, transporting and lifting the boxes into place.
 - 3. Fill oil/separator with approximately 24" of water for ballast to hold position and avoid floating during installation
 - 4. Ensure sufficient overburden. Anchor and strap unit if required.
 - 5. Install 6" concrete blocks in the excavated hole sufficient to support the OWS, and place the oil separator box on top of these blocks. The blocks should be set at each corner and in the middle. The tops of these blocks shall be set level. One to two feet of flowable, high slump, small aggregate concrete should be poured under and around the box. Be sure that the box has at least two feet of water in it prior to pouring the bedding.
- C. Join and seal PVC plumbing to oil separator box tubes and locate in correct position.
- D. Carefully, backfill around the walls of the OWS and inlet and outlet utilizing pea gravel up to 6" over the top of the OWS. Complete the backfill process with compacted soil or granular material.
- E. Set OWS and/or Lift sump so that the access lid is placed 4" above finish floor elevation when located inside the building.
- F. Finish installation with floor slabs including 4" elevated area for OWS.
 - 1. Seal the edge of cover plates and boxes with tape to prevent concrete seepage into boxes. Concrete should be finished flush with top of cover plate. The cover plates must be in place when final slab is poured around boxes.

- G. Install sump and constant pressure switch.
- H. Install high oil level alarm (if applicable)
- I. Fill OWS with water and check that system is operational.

3.1 TESTING

- A. The General Contractor shall perform a stand-pipe tightness test of the OWS and associated piping in accordance with manufacturer's recommendations and regulatory requirements.
- B. Sump pump and Constant Pressure Switch shall be tested for proper operation. Sump pump check valve shall be verified to be in operation.
- C. High Oil Level Alarm (if applicable) shall be tested for proper function in accordance with manufacturer's recommendations.
- D. Provide Owner with test results.

SECTION 11303 – ABOVE- GROUND OIL/WATER SEPARATORS**PART 1: GENERAL****1.0 RELATED DOCUMENTS**

- A. The provisions of the General Conditions, Supplementary Conditions, Sections included under Division 1, General Requirements, and Division 00 of this Division are included as part of this Section as though bound herein. Refer to details and schedules on the drawings for additional requirements.

RELATED WORK**Division 22: Plumbing****SUMMARY**

- A. The Contractor shall furnish the labor, materials, and equipment in connection with the installation of pre-fabricated above-ground oil/water separator and lift sump. Work shall be as herein specified and as denoted on the accompanying Drawings but not limited to the following general terms of work:
 - 1. Sanitary sewer
 - 2. Manholes
 - 3. Oil/water separators
 - 4. Sump pump
- B. The oil/water separator shall be pre-packaged, pre-engineered, ready to install unit.

GOVERNING STANDARDS

- A. UL Subject 2215 Underwriters Laboratories Inc. Outline of Investigation for Oil/Water Separators
- B. National Fire Protection Association (NFPA 30) Flammable and Combustible Liquids Code, (NFPA 30A) Automotive and Marine Service Station Code, (NFPA 70) National Electric Code. Unified Facilities Guide Specification 13202A (July 2002) Division 13, Special Construction, Fuel Storage Systems.
- C. ASTM Specification D2996, Filament Wound Reinforced Thermosetting Resin in Pipe.
- D. EPA Test Method 1664A, Oil and Grease, Recoverable Extraction).

QUALITY ASSURANCE

- A. Test Data: The manufacturer must provide Certificate of Compliance from Underwriters Laboratories proving that the oil/water separator is capable of producing effluent with no more than 15 ppm free oil and grease (not dissolved nor chemically emulsified with soaps or detergents) when tested using the EPA Test Method 1664A. The test inlet oils are a 50/50 mixture per the UL Subject 2215 guidelines. The testing and results will show results for: Test per the UL SU2215 guidelines. The oil/water effluent cannot exceed average of 15 ppm.
- B. Oil/water separator is a fabricated steel unit constructed to meet governing standards with certification plate (UL Label) affixed.
- C. Shop Drawings: Contractor shall submit 4 copies of shop drawings. Drawings shall include all critical dimensions, locations of fittings, accessories, and installation instructions.
- D. All OWS tanks, equipment and piping materials shall be physically inspected and tested before being installed. Any defects observed shall be immediately brought to the attention of the Owner. It shall be the sole responsibility of the Contractor to correct any deficiencies, with the manufacturer in strict accordance with manufacturer's recommendations, at no additional cost to the Owner.
- G. Oil/water separators specified herein will not remove oils with specific gravities greater than 0.95, chemical or physical emulsions, dissolved hydrocarbons, or volatile organic compounds (VOC).

- H. The Contractor shall obtain and pay for all permits, tests, inspections, etc. required by the local boards that have jurisdiction over the project. All work shall be executed and inspected in accordance with all local and state codes, rules, ordinances, or regulations pertaining to the particular work involved. Should any changes in the contract drawings and specifications be required to conform to such ordinances, notify the Owner at time of submitting of bid. After entering into the contract, the Contractor shall be held responsible for the completion of all work necessary for a complete and approved installation without extra expense to the Owner.
- I. The OWS shall be a special purpose factory fabricated unit which is a standard product of a manufacturer regularly engaged in the production of such equipment with similar units operating for a minimum of five years.

WARRANTY

- A. Manufacturer shall provide a 30 year warranty on performance of the Oil / Water Separator.

PART 2: PRODUCTS

2.0 ACCEPTABLE MANUFACTURERS

- A. Zurn or approved equal.
 - 1. Manufacturer approved equals must be submitted to Owner for approval at least 3 days prior to bid due date.

2.1 OIL/WATER SEPARATOR TANKS:

- A. Provide Zurn Z-1186 size 700 prefabricated oil/water separator with draw-off provisions and miscellaneous fittings and accessories located as denoted on the Drawings.
Manufacturers: Subject to compliance with requirements, provide products per construction documents. Refer to Plumbing plans
- B. Tank must be vented.
- C. Tank shall be capable of storing liquids with specific gravity of up to 1.0.
- D. Tank shall be capable of storing grease and oils at temperatures not to exceed 100 degrees Fahrenheit at the internal tank surface.
- F. Tanks shall be chemically inert to petroleum products.
- G. Threaded fittings on UL labeled tanks shall be of a material of construction consistent with the requirements of the UL label. Fittings to be supplied with thread protectors. See contract drawings for size and locations of fittings.
- H. Threaded fittings on UL labeled tanks shall have nylon bushings installed for isolation purposes, unless specified piping is PVC or FRP.
- I. Separator shall be equipped with draw-off for waste oil removal.
- J. Separator shall be installed with a Z1108 flow control and a Z1090 backwater valve.

2.2 CAPABILITY AND DIMENSIONAL REQUIREMENTS

- A. The following information is dependent on the system design and shall be provided by the Owner prior to project bid:
 - 1. Oil/water separator shall be as indicated on drawings.
 - 2. Flow rate shall be from zero (0) to 20 gallons per minute.
 - 3. Nominal volume of the separator tank shall be 10 gallons.
 - 4. Inlet free oil specific gravity shall range from 0.70 to 0.95.
 - 5. Inlet free oil concentration shall be no more than 200,000 parts per million.
 - 6. Effluent free oil shall be no greater than 15 parts per million.
 - 7. Inlet flange diameter shall be 3 inches.
 - 8. Outlet flange diameter shall be 3 inches.
 - 9. Nominal overall length of the tank shall be 27".

10. Nominal outside width of the separator shall be 16-3/4".
11. Operating temperatures of the influent oil/water mixture shall range from 40 degrees Fahrenheit to 120 degrees Fahrenheit.
12. Bolt down lid shall be provided.
13. Location – See standard tank drawings

2.3 OIL/WATER INTERFACE FLOAT SENSOR (if applicable):

- A. Provide an Oil/Water Interface Alarm Sensor(s) that is used to determine two separate high waste oil levels in the separator. Level one is to activate at 20% oil and activates a visual alarm. Level two is to activate at 40% oil and activates a visual and audible alarm.
- B. The oil/water interface sensor shall be furnished by the oil/water separator manufacturer.
- C. The Contractor is responsible for finalizing the height of the riser pipe and for contacting the oil/water separator manufacturer with the details so the proper length model can be provided.
- D. First Oil Level Warning Alarm: This alarm warns that the oil/water separator tank is at a high level and the oil will need to be removed soon.
- E. Second Oil Level Warning Alarm: This alarm warns that the oil/water separator tank is at a dangerously high level and the oil will need to be removed immediately.

VENT PIPING

- A. Provide vent materials according to the schedule below. Contractor to use 2-inch FRP or PVC single wall piping.
- B. Vent Cap: 2-inch sch. 40 PVC with turn down elbow at top.
- C. All vents must be separate. Do not manifold with other vent piping.

PIPE MATERIALS:

- A. Provide the following materials as specified on the drawings.
- B. Ductile iron pipe, designated DIP on the drawings, shall be centrifugally cast push on joint ductile iron pipe conforming to ANSI Specification A21.51 with rubber gaskets conforming to ANSI Specification A21.11. Fittings shall be ductile iron conforming to ANSI Specification A21.10.
- C. Polyvinyl chloride pipe and fittings, designated SCH 40 PVC on the drawings, shall conform to ASTM D3034.

2.6 LIFT SUMP

- A. In some cases a lift sump may be installed inside the pit area of the building and piped to the OWS in accordance with drawings.
- B. The lift sump will be equipped with a sump pump and Constant Pressure Switch provided and installed by the General Contractor as follows:
 1. Sump Pump – Zoeller Model N-153 115volt single phase w/ 1-1/2" discharge, 1/2hp vortex impeller capable of handling 3/4" spherical solids (see attached cut sheet). Utilize Zoeller Model 30-0164, 1-1/2" cast iron check valve. In areas where an explosion proof sump pump is required by regulating authorities, the contractor shall utilize a Zoeller NX282 115volt single phase w/ 2" discharge 1/2hp vortex impeller capable of handling 2" spherical solids. Utilize Zoeller Model 30-0152, 2" cast iron check valve.
 2. Constant Pressure Switch (CPS). A constant pressure switch shall be installed at the discharge side of the OWS chamber. This is designed as means to contain spills and overfills from being discharged directly into the sanitary sewer. The General Contractor shall furnish and install an Allen Bradley model #800T-A601 momentary contact push-button switch in a NEMA Type 4 enclosure Allen Bradley #700T-ITZ. Verify connection requirements. Note: Sump shall not run unless the push button is engaged.

PART 3: EXECUTION**3.0 INSTALLATION**

- A. The interceptor may be placed on the floor, partially recessed in the floor, recessed with top flush with the floor, or fully recessed below the floor, in order to accommodate piping and structural conditions. However, unless specified otherwise or conditions prevent, the OWS shall be placed on the floor.
- B. Solid waste material shall not be permitted to enter the OWS.
- C. Install sump pump in lift sump with a constant pressure switch (if applicable).
- D. Install high oil level alarm (if applicable).
- E. Fill OWS with water and check that system is operational.
- F. Install flow control device (Z1108), furnished with the OWS in accordance with manufacturer's recommendations. The OWS incorporates two features to maintain equilibrium:
 - 1) Vented flow control device, and
 - 2) Air relief by-pass.

NOTE: The flow control device must be properly vented to permit air to properly mix with the fluid entering the interceptor. Air facilitates separation and, more importantly, is necessary to maintain the proper pressure and thus the proper operating level within the separation chamber. For example, without a properly vented flow control device, little or no air would be drawn into the interceptor during use, causing the operating level to rise, pushing the grease residue toward the cover. If the grease layer reaches the air relief by-pass, grease could be pushed on into the outlet. If air enters an interceptor that does not utilize an air relief by-pass, the buildup in air pressure has nowhere to go and begins pushing the grease and water layers downward toward the bottom of the interceptor.. If pressure continues to build, grease would eventually be forced under the baffle plate and out of the unit. The presence of a vented flow control device and air relief by-pass is a key element in the efficient operation of a grease interceptor. If one or both of these items are not present, flow rate through the interceptor and operational performance can be severely compromised.

3.1 VENTING

- A. The Zurn Z1186-ST and Z1188-ST Series oil interceptor with integral storage tank is furnished with 1-1/2" IPS vent connections located on all sides of the unit to accommodate the installation of the vent piping. Three of the vent connections are located on the oil storage tank, and one vent connection is located on the interceptor body upstream of the double wall trap seal. It is important that the unit be vented using any one of the vent connections provided. This will allow any of the volatile gases rising from the intercepted substances to be carried from the interceptor and storage tank to the atmosphere.
- B. All Zurn oil interceptors are furnished with 1-1/2" IPS vent and drawoff connections on both the right and left hand sides of the interceptor with plugs in one side. If necessary, the vent and drawoff connections can be changed from one side to the other at the time of installation, by switching the plugs.
- C. The vent connections are located above the adjustable gravity oil draw-off standpipe in the intercepting chamber. Thus, the volatile gases rising from the intercepted substances are carried from the interceptor to the atmosphere.

3.2 ADJUSTABLE DRAW-OFF

- A. The oil interceptor is furnished with a 1-1/2" IPS adjustable oil draw-off assembly. This draw-off can be furnished on either the right or left hand side of the interceptor. The oil draw-off consists of an adjustable pipe combination on the inside of the intercepting chamber, and a pipe connection from the internal adjustable standpipe on the side of the oil interceptor body to connect to an oil drain line from the oil interceptor to an oil storage tank.

- B. The adjustable standpipe can be raised or lowered inside the interceptor chamber to the proper height for draining off the separated oils and similar light density substances that have separated and floated to the surface of the interceptor chamber.
- C. After the oils and other substances have been accumulated in the interceptor, they can be drained from the interceptor chamber by gravity flow through the internal standpipe. The standpipe is adjusted so that the opening is located at 1/8" above the top of the water flow level in the interceptor chamber.
- D. There is no need to manually skim or dip out the oil, since the oil will drain off by gravity flow through the adjustable draw-off standpipe after it has been properly adjusted and tightened.

3.3 SETTING ADJUSTABLE DRAW-OFF

- A. The Zurn oil interceptor with integral storage tank should be completely installed and all connections made, including the adjustable draw-off gate plate.
- B. Loosen all bolts securing the gate plate as well as those above the gate plate. Slide the gate plate up to its highest position and tighten in place.
- C. Clean water is then run through the oil interceptor at the flow the interceptor is rated for. This establishes the operating water level. The operating water level is marked on the inside of the intercepting chamber. The marking of the operating water level must be done while there is water flowing through the interceptor. If the mark is established at the static water level, excess amounts of water will pass over the draw-off gate plate when the flow rate through the interceptor increases to its rated capacity. In this case, the draw-off gate plate would become submerged.
- D. Loosen the bolts securing the gate plate and slide the gate plate down so that the top edge is 1/8" above the operating water level mark.
- E. Tighten bolts securing the gate plate at this level.
- F. After the oil interceptor is put in operation and oil and low density substances will accumulate at the surface to a depth of 2" to 2-1/2" before the adjustable draw-off will start.
- G. Draw-off setting should be checked. Check draw-off by taking samples while the oil interceptor is in operation.

3.4 OIL FLOAT SENSOR INSTALLATION (IF APPLICABLE)

- A. Remove the covers that are located over the storage tank portion of the interceptor.
- B. Identify the discharge method in which the oil draws off into the storage tank (either an adjustable pipe/tube assembly (i.e. Z1186-83) or an adjustable gate plate assembly (i.e. Z1186-ST))
- C. Measure and record the length (L) across and width (W) across the storage tank from interior wall to interior wall (inches).
- D. Measure the oil volume height (H) of the storage tank from the bottom interior base to the bottom of the oil discharge point in inches (See Figure 1 below)
 Note: For Draw-Off Plate Type, ensure that the plate is adjusted to its lowest possible position before measuring the oil volume height.
- E. Multiply (L) x (W) x (H) and divide by 231 to compute the minimum storage volume (gallons) of oil storage in the tank.
- F. Multiply the oil storage volume from Step 5 by 80%. Take this number, divide by 231, then divide by length (L), then divide by width (W). The resultant will be a new height value in inches (H1) where the oil volume is at 80% of its capacity. This is the height from the bottom interior of the storage tank to where the Float Sensor should be located.
- G. Locate the Sensor Enclosure Box inside of the storage tank and remove the treadplate cover. Measure the distance from the exterior bottom of the enclosure box to the interior bottom of the storage tank (H2) in inches.
- H. Solve H2 - H1 to obtain the overall length of the float sensor assembly. Subtract 1-5/16" from this resultant to obtain the Length of 1/2" Conduit (Lc) necessary to connect the Float Sensor to the Sensor Box.
- I. Cut a piece of 1/2" conduit to the length (Lc) determined in Step 8. Deburr both ends

- and clean with PVC cleaner.
- J. Remove the cover of the Sensor Box by unscrewing the four machine screws that hold it on. Dry fit the Float Sensor, the PVC Conduit, and the Sensor Box together and place the assembly into the Sensor Box Enclosure.
 - K. With the assembly together and installed in the Sensor Enclosure Box, re-measure the distance from the bottom interior of the storage tank to the Float Sensor (H1) to verify that the 1/2" Conduit is cut to proper length.
 - L. Once (H1) is verified as correct, disassemble all components to prepare for actual assembly. If (H1) measures different than the calculated value of Step 6, repeat Steps 9 thru 11 to re-cut conduit to proper length.
 - M. Apply PVC Cement to one side of the 1/2" Conduit and insert into the socket fitting of the Sensor Box. Allow a few seconds for the cement to set up.
 - N. Run the Float Sensor wires through the other end of the 1/2" Conduit and out through the top of the sensor box. Apply PVC Cement to the other side of the Conduit and insert into the socket fitting of the Float Sensor. Allow a few seconds for the cement to set up.
 - O. Apply a bead of Silicon Sealant to the underside of the Sensor Box. Insert the Sensor Box into the Sensor Enclosure Box and secure using four #8-32 x 1/2" steel or stainless steel machine screws.
 - P. Coil the sensor wire up and place inside of Sensor Box. Re-secure the cover to the sensor box.
 - Q. Place the Interceptor Operating Instructions and Wiring Diagram inside of the Sensor Enclosure Box and re-secure the tread plate cover.
 - R. Re-secure the Oil Interceptor covers.
 - S. Locate the Display Box (See Figure 7 below) that is provided with the sensor package and remove the cover of the Display Box by unloosening the four machine screws that secure it. Inside of the Display Box is an electronic component that looks like a dial with numbers on it. This component causes a delay between the time the Float Sensor rises and the time that the audible and visible alarms are activated in the Display Box. The dial is normally set to somewhere between 2 and 3 minutes. Turn the dial counterclockwise until the mark lines up with Zero. This will eliminate any delay between the float signal and the display box alarms.
 - T. Re-secure the cover to the Display Box.

3.5 TESTING

- A. The General Contractor shall perform a tightness test of the OWS and associated piping in accordance with manufacturer's recommendations and regulatory requirements.
- B. Sump pump and Constant Pressure Switch shall be tested for proper operation. Sump pump check valve shall be verified to be in operation.
- C. Oil Level Sensor (if applicable) shall be tested for proper function in accordance with manufacturer's recommendations.
- D. Oil Draw-off shall be tested for proper operation.
- E. Provide Owner with test results.

SECTION 22050 - COMMON WORK RESULTS FOR PLUMBING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated; Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Available Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.

- E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Available Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum working pressure as required to suit system pressures.
 - 1. Available Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
- c. Metraflex Co.
- d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- 3. Pressure Plates: Carbon steel. Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.0 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping: Use the following:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

- b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
- c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position the pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Refer to Division 07 Section "Penetration Fire-stopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.1 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846 Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Non-pressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.2 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Coordinate locations with all other trades before installing.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.6 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

SECTION 22052 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fiberglass pipe hangers.
 - 4. Metal framing systems.
 - 5. Fiberglass strut systems.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Pipe positioning systems.
 - 10. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
 - 3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
 - 4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-58, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner) for the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.
 - 5. Pipe positioning systems.

- B. Shop Drawings (if requested by Owner): Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Welding certificates (if requested by Owner).

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Available Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. Grinnell Corp.
 - 4. Piping Technology & Products, Inc.
- C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, Type 59, shop or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.
 - 1. Available Manufacturers:

- a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Unistrut Corp.; Tyco International, Ltd.
- B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.
 - 1. Available Manufacturers:
 - a. Plasti-Fab, Inc.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-4, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Power-Strut Div.; Tyco International, Ltd.
 - 3. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FIBERGLASS STRUT SYSTEMS

- A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-4, made of fiberglass channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Available Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Available Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Available Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.

2.8 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Available Manufacturers:
 - a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Available Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.10 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.11 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 EXECUTION

3.0 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 - 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 - 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 - 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 - 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-58 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.
- P. All riser/vertical applications to follow MSS SP-58 guidelines.

3.1 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- I. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- Q. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

- a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood inserts.
- 6. Insert Material: Length at least as long as protective shield.
- 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/4 inches.

3.5 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

SECTION 22053 - GENERAL-DUTY VALVES FOR PLUMBING PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze angle valves.
 - 2. Brass ball valves.
 - 3. Bronze ball valves.
 - 4. Iron ball valves.
 - 5. Iron, single-flange butterfly valves.
 - 6. Iron, grooved-end butterfly valves.
 - 7. Bronze lift check valves.
 - 8. Bronze swing check valves.
 - 9. Iron swing check valves.
 - 10. Iron swing check valves with closure control.
 - 11. Iron, grooved-end swing check valves.
 - 12. Iron, center-guided check valves.
 - 13. Iron, plate-type check valves.
 - 14. Bronze gate valves.
 - 15. Iron gate valves.
 - 16. Bronze globe valves.
 - 17. Iron globe valves.
 - 18. Lubricated plug valves.
 - 19. Chainwheels.
- B. Related Sections:
 - 1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of valve indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.0 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.1 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

- d. Ends: Threaded.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, Bronze Angle Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- C. Class 150, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Kitz Corporation.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.
- D. Class 150, Bronze Angle Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.2 BRASS BALL VALVES

- A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - 2. Description:

- a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- C. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- D. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.

- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Regular.

2.3 BRONZE BALL VALVES

- A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

- D. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Jenkins Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.

2.4 IRON BALL VALVES

- A. Class 125, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Kitz Corporation.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Split body.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Ends: Flanged.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

- B. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- D. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- E. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.

- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- F. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tyco Fire Products LP; Grinnell Mechanical Products.
 - b. Victaulic Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.
- B. 300 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. NIBCO INC.
 - c. Tyco Fire Products LP; Grinnell Mechanical Products.
 - d. Victaulic Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. NPS 10 and Larger CWP Rating: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

2.7 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 125, Lift Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.

2.8 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.
- C. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.9 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
- B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Composition.
 - g. Seat Ring: Bronze.
 - h. Disc Holder: Bronze.

- i. Disc: PTFE or TFE.
- j. Gasket: Asbestos free.
- C. Class 250, Iron Swing Check Valves with Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.10 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.
- B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and weight.

2.11 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP, Iron, Grooved-End Swing Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire Products LP; Grinnell Mechanical Products.
 - c. Victaulic Company.

2. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A 536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring-operated, ductile iron or stainless steel.

2.12 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer.
 - e. Seat: Bronze.
- B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Compact wafer.
 - e. Seat: Bronze.
- D. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.

- d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- E. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: Bronze.
- F. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- G. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: Bronze.
- H. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: Bronze.
- I. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hammond Valve.
 - b. Milwaukee Valve Company.

- c. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer.
 - e. Seat: EPDM or NBR.
- J. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM or NBR.
- K. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Compact wafer.
 - e. Seat: EPDM or NBR.
- L. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM or NBR.
- M. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: EPDM or NBR.

- N. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 126, gray iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM or NBR.
- O. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Compact wafer, spring loaded.
 - e. Seat: EPDM or NBR.
- P. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - d. Style: Globe, spring loaded.
 - e. Ends: Flanged.
 - f. Seat: EPDM or NBR.

2.13 IRON, PLATE-TYPE CHECK VALVES

- A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Flomatic Corporation.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: Bronze.
- B. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.

- b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - e. Seat: Bronze.
- C. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 400 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: Bronze.
- D. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 500 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - e. Seat: Bronze.
- E. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Sure Flow Equipment Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Wafer, spring-loaded plate.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.
- F. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.
- G. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - e. Seat: EPDM or NBR.
- H. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sure Flow Equipment Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 400 psig.
 - c. Body Design: Wafer, spring-loaded plate.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.
- I. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Sure Flow Equipment Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 400 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM or NBR.
- J. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: API 594.
 - b. CWP Rating: 500 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - e. Seat: EPDM or NBR.

2.14 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.

- e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, RS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- C. Class 150, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- D. Class 150, RS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.16 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.

- b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.
- C. Class 250, NRS, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.
- D. Class 250, OS&Y, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

2.16 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.
- C. Class 150, Bronze Globe Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.17 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.
- B. Class 250, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.18 LUBRICATED PLUG VALVES

- A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.

2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- E. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- F. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- G. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.
- H. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. CWP Rating: 400 psig.
 - c. Body Material: ASTM A 48 or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
 - d. Pattern: Venturi.
 - e. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION**3.0 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.2 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, gate, or plug valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: Globe or angle or ball valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 150, nonmetallic disc.
 3. Ball Valves: One piece, full port, brass or bronze with brass trim.
 4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
 5. Bronze Gate Valves: Class 150, RS.
 6. Bronze Globe Valves: Class 150, nonmetallic disc.
 7. Iron Ball Valves: Class 150.
 8. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
 9. Iron, Grooved-End Butterfly Valves: 300 CWP.
 10. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.
 11. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
 12. Iron, Grooved-End Swing Check Valves: 300 CWP.
 13. Iron, Center-Guided Check Valves: Class 150, compact-wafer, resilient seat.
 14. Iron, Plate-Type Check Valves: Class 150; dual plate; resilient seat.
 15. Iron Gate Valves: Class 250.
 16. Iron Globe Valves: Class 250.

3.5 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 2. Bronze Angle Valves: Class 150, nonmetallic disc.
 3. Ball Valves: Two piece, full port, brass or bronze with brass trim.
 4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
 5. Bronze Gate Valves: Class 150, RS.
 6. Bronze Globe Valves: Class 150, nonmetallic disc.
- B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 2. Iron Ball Valves: Class 150.
 3. Iron Swing Check Valves: Class 250, nonmetallic-to-metal seats.
 4. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
 5. Iron, Grooved-End Swing Check Valves: 300 CWP.
 6. Iron Gate Valves: Class 250, OS&Y.
 7. Iron Globe Valves: Class 250.
 8. Lubricated Plug Valves: Class 250, regular gland, flanged.

SECTION 22054 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Freestanding and restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Seismic snubbers.
 - 12. Restraining braces and cables.
 - 13. Steel and inertia, vibration isolation equipment bases.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Seismic restraints shall be designed and installed in accordance with local codes and shall be acceptable to the authority having jurisdiction.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner) for the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Delegated-Design Submittal (if requested by Owner): For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings (if requested by Owner): Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates (if requested by Owner).
- E. Qualification Data (if requested by Owner): For professional engineer and testing agency.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approved by ICC-ES, or pre-approved by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 PRODUCTS

2.0 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.

3. Isolation Technology, Inc.
4. Vibration Mountings & Controls, Inc.
- D. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel base-plates, and factory cut to sizes that match requirements of supported equipment.
 1. Resilient Material: Oil- and water-resistant neoprene, rubber or hermetically sealed compressed fiberglass.
- E. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with base-plate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- F. Restrained Mounts: All-directional mountings with seismic restraint.
 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- G. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Base-plates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to base-plate underside. Base-plates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- H. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base-plate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to base-plate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- I. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
 1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

- J. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- K. Spring Hangers: Combination coil-spring and elastomeric insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- L. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- M. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.
- N. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.1 VIBRATION ISOLATION EQUIPMENT BASES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - 1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.
 3. Isolation Technology, Inc.
 4. Mason Industries.
- D. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- E. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. Amber/Booth Company, Inc.
 2. Hilti, Inc.
 3. Unistrut; Tyco International, Ltd.
- D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- E. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil and water resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.
- F. Channel Support System: MFMA-3, shop or field fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

- G. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- H. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- I. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- J. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- L. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- M. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
 - 1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inches.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127 and NFPA 13.
 - 2. Space lateral supports a maximum of 20 feet o.c., and longitudinal supports a maximum of 40 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Domestic Water Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Owner's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
 - 11. Test and adjust air-mounting system controls and safeties.
 - 12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust piping isolators after system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of sprint isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

SECTION 22070 - PLUMBING INSULATION**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Mastics.
 - 5. Lagging adhesives.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Tapes.
 - 9. Securements.
 - 10. Corner angles.
- B. Related Sections include the following:
 - 1. Division 21 Fire Suppression
 - 2. Division 23 Section "HVAC Insulation."

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings (if requested by Owner):
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Samples (if requested by Owner): For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Qualification Data (if requested by Owner): For qualified Installer.

- E. Material Test Reports (if requested by Owner): From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- F. Field quality-control reports (if requested by Owner).

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.0 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- D. Calcium Silicate:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Industrial Insulation Group; Thermo-12 Gold.
 - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.
- H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corp.; Commercial Board.

- b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
- J. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; 1000 Series Spin-Glas.
 - b. Owens Corning; High Temperature Industrial Board Insulations.
- K. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.1 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Products, Division of ITW; CP-97.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
 - c. Marathon Industries, Inc.; 290.
 - d. Mon-Eco Industries, Inc.; 22-30.
 - e. Vimasco Corporation; 760.
- C. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - b. Marathon Industries, Inc.; 225.
 - c. Mon-Eco Industries, Inc.; 22-25.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 1. For indoor applications, use lagging adhesives that have a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
 4. Service Temperature Range: Minus 50 to plus 180 deg F.
 5. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Marathon Industries, Inc.; 405.
 - b. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC bi-axially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dow Chemical Company; Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 5. PVDC Jacket for Outdoor Applications: 6-mil thick, white PVDC bi-axially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dow Chemical Company; Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Dow Chemical Company; Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Very Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dow Chemical Company; Saran 540 Vapor Retarder Tape.
 2. Width: 3 inches.
 3. Film Thickness: 6 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.

2.8 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base-plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Base-plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Base-plate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Base-plate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Base-plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Base-plate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, galvanized steel.
 1. Manufacturers: Subject to compliance with requirements, provide one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat-tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Hand-holes.
 6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 Section "Penetration Fire-stopping" and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Fire-stopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.6 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect field-insulated equipment by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 2. Inspect pipe, fittings, strainers, and valves by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Domestic water pump insulation shall be one of the following:

- D. Domestic water, domestic hot-water hydro-pneumatic tank insulation shall be one of the following:
 - 1. Cellular Glass: 1-1/2 inches thick.
 - 2. Flexible Elastomeric: 1 inch thick.
 - 3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
 - 4. Mineral-Fiber Pipe and Tank: 1 inch thick.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

SECTION 22111 - DOMESTIC WATER PIPING

PART 1- GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Under-ground slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Encasement for piping.
 - 3. Specialty valves.
 - 4. Flexible connectors.
 - 5. Water meters furnished by utility company for installation by Contractor.
 - 6. Water meters.
 - 7. Escutcheons.
 - 8. Sleeves and sleeve seals.
 - 9. Wall penetration systems.
- B. Related Section:
 - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Water meters.
 - 6. Backflow preventers and vacuum breakers.
 - 7. Escutcheons.
 - 8. Sleeves and sleeve seals.
 - 9. Water penetration systems.
- B. Water Samples (if requested by Owner).
- C. Coordination Drawings (if requested by Owner): For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.

- 2. Domestic water piping.
- D. Field quality-control reports (if requested by Owner).

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2- PRODUCTS

2.0 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.1 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 5. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - 6. Copper Push-on-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) NVent LLC.
 - b. Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
 - 7. Copper-Tube Extruded-Tee Connections:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) T-DRILL Industries Inc.
 - b. Description: Tee formed in copper tube according to ASTM F 2014.
 - 8. Grooved-Joint Copper-Tube Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Victaulic Company.
 - b. Copper Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 2. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
 - b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
 - c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
 2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
 - a. Gaskets: AWWA C111, rubber.
 2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
 - a. Gaskets: AWWA C111, rubber.
- C. Plain-End, Ductile-Iron Pipe: AWWA C151.
 1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Victaulic Company.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE, FITTINGS AND JOINING/FUSION

A. Resin and Material Requirements

1. All materials shall be manufactured from a PE 4710 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material shall meet the specifications of ASTM D 3350 with a minimum cell classification of 445474C. HDPE pipe and fittings shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. HDPE products shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.

2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- E. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
 1. Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Sheet or Tube.
- C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.
- D. Color: Black or Natural.

2.6 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.7 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc.
 - d. JCM Industries.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Pipeline Seal and Insulator, Inc.
 - 2. Description:
 - a. Non-conducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.

- d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - 2. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Female threaded.
 - d. Lining: Inert and non-corrosive, thermoplastic.
- F. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
 - 2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and non-corrosive, propylene.

2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flex-Hose Co., Inc.
 - 2. Hyspan Precision Products, Inc.
 - 3. Mercer Rubber Co.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 200 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.10 WATER METERS

- A. Displacement-Type Water Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB.
 - b. Badger Meter, Inc.
 - c. Mueller Company; Water Products Division.
 - 2. Description:

- a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility.
 - e. Case: Bronze.
 - f. End Connections: Threaded.
- B. Turbine-Type Water Meters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB.
 - b. Badger Meter, Inc.
 - c. Mueller Company; Water Products Division.
 - 2. Description:
 - a. Standard: AWWA C701.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: Turbine; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company .
 - e. Case: Bronze.
 - f. End Connections for Meters NPS 2 and Smaller: Threaded.
 - g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.
- C. Compound-Type Water Meters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB.
 - b. Badger Meter, Inc.
 - 2. Description:
 - a. Standard: AWWA C702.
 - b. Pressure Rating: 150-psig working pressure.
 - c. Body Design: With integral mainline and bypass meters; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections: Flanged.
- D. Fire-Service-Type Water Meters:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Badger Meter, Inc.
 - b. Mueller Company; Water Products Division.
 - 2. Description:
 - a. Standard: AWWA C703 and UL listing.
 - b. Pressure Rating: 175-psig working pressure.
 - c. Body Design:
 - 1) Turbine-Type Water Meters: With strainer, and with meter on bypass.
 - a) Strainer: Full size, matching water meter.
 - b) Bypass Meter: AWWA C701, turbine type with bronze case; not less than NPS 2.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections for Meters NPS 2 and Smaller: Threaded.
 - g. Pipe Connections for Meters NPS 2-1/2 and Larger: Flanged.
- E. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

- F. Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.11 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. One Piece, Stamped Steel: Chrome-plated finish with spring clips.
- E. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- F. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge spring clips.
- G. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- H. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- D. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
- E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- F. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- G. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.13 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex, Inc.
 - 4. Pipeline Seal and Insulator, Inc.

- B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Plastic.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.14 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
 - 1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 - 2. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 - 3. Housing-to-Sleeve Gasket: EPDM rubber.
 - 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
 - 5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53, Schedule 40, zinc-coated steel pipe.

2.15 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3- EXECUTION

3.0 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- H. Install domestic water piping level and plumb.
- I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- J. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- N. Install piping adjacent to equipment and specialties to allow service and maintenance.
- O. Install piping to permit valve servicing.
- P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- Q. Install piping free of sags and bends.
- R. Install fittings for changes in direction and branch connections.
- S. Install PEX piping with loop at each change of direction of more than 90 degrees.
- T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Copper-Tubing, Push-on Joints: Clean end of tube. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- J. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
- K. Steel-Piping Grooved Joints: Cut or roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. PEX Piping Joints: Join according to ASTM F 1807.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2

and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 and smaller and butterfly valves for piping NPS 2-1/2 and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 FLEXIBLE CONNECTOR INSTALLATION

- A. Install bronze-hose flexible connectors in copper domestic water tubing.
- B. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.7 WATER METER INSTALLATION

- A. Rough-in domestic water piping for water meter installation according to utility company's requirements.
- B. Install water meters according to AWWA M6, utility company's requirements, and the following:
- C. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
- D. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities

having jurisdiction.

- E. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
- F. Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.
- G. Install remote registration system according to standards of utility company and of authorities having jurisdiction.
- H. Irrigation system shall be metered separately.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 - 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish.
 - 5. Bare Piping in Equipment Rooms: One piece, cast brass.
 - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.11 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.

- J. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PVC.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. PVC pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 - 4. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Comply with requirements in Division 07 Section "Penetration Fire-stopping" for fire-stop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 WALL PENETRATION SYSTEM INSTALLATION

- A. Install wall penetration systems in new, exterior concrete walls.
- B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.14 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

- B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.16 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - c. Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - d. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - e. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - f. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
 1. Soft copper tube, ASTM B 88, Type K or ASTM B 88, Type L; wrought-copper solder-joint fittings; and brazed copper pressure-seal fittings; and pressure-sealed joints.

- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
 - 1. Soft copper tube, ASTM B 88, Type K or ASTM B 88, Type L; wrought-copper solder-joint fittings; and brazed joints.
 - 2. Mechanical-joint, ductile-iron pipe; standard or compact pattern mechanical-joint fittings; and mechanical joints.
 - 3. Push-on-joint, ductile-iron pipe; standard or compact pattern push-on-joint fittings; and gasketed joints.
 - 4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard or compact pattern mechanical-joint fittings; and mechanical joints.
 - 2. Push-on-joint, ductile-iron pipe; standard or compact pattern push-on-joint fittings; and gasketed joints.
 - 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard or soft copper tube, ASTM B 88, Type L; wrought copper solder-joint fittings; and brazed joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; cast or wrought copper solder-joint fittings; and soldered joints.
 - 3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 4. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on-joint fittings; and push-on joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; cast or wrought copper solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint copper-tube appurtenances; and grooved joints.
- J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; cast or wrought copper solder-joint fittings; and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint copper-tube appurtenances; and grooved joints.
- K. Above ground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12, shall be the following:
 - 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

3.19 VALVE SCHEDULE

- A. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

SECTION 22131 - SANITARY WASTE AND VENT PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Sewerage Pumps."
 - 2. Division 22 Section "Chemical Waste-Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Sanitary Sewer, Force-Main Piping: 150 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For pipe, tube, fittings, and couplings.
- B. Shop Drawings (if requested by Owner):
 - 1. Design Calculations (if requested by Owner): Signed and sealed by a qualified professional engineer for selecting seismic restraints.
- C. Field quality-control inspection and test reports (if requested by Owner).

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS**2.0 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class/es.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) Mission Rubber Co.
 - 2) Tyler Pipe; Soil Pipe Div.
 - 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Tyler Pipe; Soil Pipe Div.
 - 3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) MG Piping Products Co.
- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Available Manufacturers:
 - a. ANACO.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

2. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint Systems:
 1. Available Manufacturers:
 - a. Victaulic Company.
 2. Grooved-End, Ductile-Iron Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

2.5 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.6 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.
- D. Solvent Cement and Adhesive Primer:
 1. Use ABS solvent cement that has a VOC content of 325 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.
- D. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 SPECIAL PIPE FITTINGS

- A. Flexible, Non-pressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 1. Available Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Co.
 - d. NDS, Inc.
 2. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Non-pressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Rigid, Unshielded, Non-pressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 1. Available Manufacturers:
 - a. ANACO.
- D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. JCM Industries, Inc.
 - c. Romac Industries, Inc.
 - d. Smith-Blair, Inc.
 2. Center-Sleeve Material: Manufacturer's standard.
 3. Gasket Material: Natural or synthetic rubber.
 4. Metal Component Finish: Corrosion-resistant coating or material.
- E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
 1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.
- F. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.

- G. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Available Manufacturers:
 - a. SIGMA Corp.

2.9 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, cross-laminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.
- B. Form Sheet or tube.
- C. Color: Black or natural.

PART 3 - EXECUTION

3.0 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel; and rigid, unshielded couplings; and hubless coupling joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 6. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings and solvent stack fittings; standard, and heavy-duty shielded, stainless-steel couplings; and hubless coupling joints.
 - 3. Steel pipe, drainage fittings, and threaded joints.
 - 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 5. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; standard shielded, stainless-steel; and rigid, unshielded couplings; and hubless coupling joints.
 - 3. Steel pipe, drainage fittings, and threaded joints.
 - 4. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - 5. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - 6. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 - 7. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 8. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless cast-iron soil pipe and fittings; standard, stainless-steel couplings; and hubless-coupling joints.
 3. Steel pipe, drainage fittings, and threaded joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and rigid, unshielded couplings; and hubless coupling joints.
 3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 4. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 5. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 7. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel; and heavy-duty shielded, cast-iron couplings; and hubless coupling joints.
 3. Solid-wall, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 4. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Steel pipe, pressure fittings, and threaded joints.
 3. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
1. Soft copper tube, Type L; copper pressure fittings; and soldered joints.
 2. Steel pipe, pressure fittings, and threaded joints.
 - a. Include grooved-joint system fittings and couplings and grooved joints where indicated.
 3. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.
 - a. Include grooved-joint system fittings and couplings and grooved joints where indicated.
 4. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.
 - a. Include grooved-joint system fittings and couplings and grooved joints where indicated.
 5. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.
- K. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.
2. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.
3. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

3.2 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- F. Install underground, steel, force-main piping.[Install encasement on piping according to ASTM A 674 or AWWA C105.]
- G. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- H. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- I. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- J. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- K. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- L. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- M. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- N. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- O. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- P. Install engineered soil and waste drainage and vent piping systems as follows:
1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- Q. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- R. Install ABS soil and waste drainage and vent piping according to ASTM D 2661.
- S. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- T. Install underground ABS and PVC soil and waste drainage piping according to ASTM D 2321.
- U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless coupling joints.
- E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- F. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- G. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 2. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
1. Horizontal Piping: Horizontal backwater valves.
 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.
- K. Install supports for vertical stainless-steel piping every 10 feet.
- L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- M. Install supports for vertical copper tubing every 10 feet.
- N. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
- O. Install supports for vertical ABS and PVC piping every 48 inches.

- P. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
 - 1. Sanitary Sewer: To exterior force main or sanitary manhole.
 - 2. Sewage Pumps: To sewage pump discharge.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

SECTION 22132 - SANITARY WASTE PIPING SPECIALTIES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Trench drains.
 - 5. Air-admittance valves.
 - 6. Roof flashing assemblies.
 - 7. Through-penetration firestop assemblies.
 - 8. Miscellaneous sanitary drainage piping specialties.
 - 9. Flashing materials.
 - 10. Grease interceptors.
- B. Related Sections include the following:
 - 1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
- B. Shop Drawings (if requested by Owner): Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that grease interceptors, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification (if requested by Owner): Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit (if requested by Owner): Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports (if requested by Owner).
- E. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.0 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.14.1.
 3. Size: Same as connected piping.
 4. Body: Cast iron.
 5. Cover: Cast iron with bolted or threaded access check valve.
 6. End Connections: Hub and spigot or hubless.
 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Size: Same as floor drain outlet.
 3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
 4. Check Valve: Removable ball float.
 5. Inlet: Threaded.
 6. Outlet: Threaded or spigot.
- C. Horizontal, Plastic Backwater Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Zurn Plumbing Products Group; Light Commercial Operation.
2. Size: Same as connected piping.
3. Body: ABS.
4. Cover: Same material as body with threaded access to check valve.
5. Check Valve: Removable swing check.
6. End Connections: Socket type.

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 3. Size: Same as connected drainage piping
 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Countersunk brass plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group
 2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 3. Size: Same as connected branch.
 4. Type: Threaded, adjustable housing.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: Required.
 7. Outlet Connection: Threaded.
 8. Closure: Brass plug with straight threads and gasket.
 9. Adjustable Housing Material: Plastic with threads.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Frame and Cover Shape: Square.
 12. Top Loading Classification: Heavy Duty.
 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Cast-Iron Wall Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M. Include wall access.
 3. Size: Same as connected drainage piping.

4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Countersunk, drilled-and-threaded plug.
 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
- D. Plastic Floor Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Size: Same as connected branch.
 3. Body: PVC.
 4. Closure Plug: PVC.
 5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group.
 2. Standard: ASME A112.6.3.
 3. Pattern: Floor drain.
 4. Body Material: Gray iron.
 5. Seepage Flange: Required.
 6. Clamping Device: Required.
 7. Outlet: Bottom.
 8. Backwater Valve: Not required.
 9. Coating on Interior and Exposed Exterior Surfaces: Not required.
 10. Sediment Bucket: Not required.
 11. Top or Strainer Material: Nickel bronze.
 12. Top of Body and Strainer Finish: Nickel bronze.
 13. Top Shape: Square.
 14. Dimensions of Top or Strainer: 6 inch Square.
 15. Top Loading Classification: Heavy Duty.
 16. Funnel: See Plans.
 17. Inlet Fitting: Not required.
 18. Trap Material: Not required.
 19. Trap Pattern: Not required.
 20. Trap Features: Not required.
- B. Plastic Floor Drains:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Standard: ASME A112.6.3.
 3. Material: ABS or PVC.
 4. Seepage Flange: Required.
 5. Clamping Device: Required.
 6. Outlet: Side.

7. Sediment Bucket: Not required.
8. Top or Strainer Material: Bronze.
9. Top of Body and Strainer Finish: Nickel bronze.
10. Top Shape: Square.
11. Dimensions of Top or Strainer: 6 inch Square.
12. Trap Material: Not required.
13. Trap Pattern: Not required.

2.3 TRENCH DRAINS

- A. Trench Drains:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.6.3 for trench drains.
 3. Material: Ductile or gray iron.
 4. Flange: Seepage.
 5. Clamping Device: Not required.
 6. Outlet: Bottom.
 7. Grate Material: Stainless steel.
 8. Grate Finish: Not required.
 9. Dimensions of Frame and Grate: See Drawings.
 10. Top Loading Classification: Extra Heavy-Duty.
 11. Trap Material: Not required.
 12. Trap Pattern: Not required.

2.4 AIR ADMITTANCE VALVES

- A. Stack Air-Admittance Valves:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Studor, Inc.
 3. Standard: ASSE 1050 for vent stacks.
 4. Housing: Plastic.
 5. Operation: Mechanical sealing diaphragm.
 6. Size: Same as connected stack vent or vent stack.
- B. Wall Box:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Studor, Inc.
 3. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
4. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.5 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
- B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - 1. Open-Top Vent Cap: Without cap.
 - 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Fire-stop Assemblies:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ProSet Systems Inc.
 - 2. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.
 - 3. Size: Same as connected soil, waste, or vent stack.
 - 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 5. Stack Fitting: ASTM A 48, gray-iron, hubless pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 6. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains:
 - 1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2. Size: Same as connected waste piping.
- B. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Floor-Drain, Trap-Seal Primer Fittings:
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- D. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

- E. Sleeve Flashing Device:
 - 1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - 2. Size: As required for close fitting of the riser or stack piping.
- F. Stack Flashing Fittings:
 - 1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- G. Vent Caps:
 - 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- H. Frost-Resistant Vent Terminals:
 - 1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
 - 2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter-flashing.
- I. Expansion Joints:
 - 1. Standard: ASME A112.21.2M.
 - 2. Body: Cast iron with bronze sleeve, packing, and gland.
 - 3. End Connections: Matching connected piping.
 - 4. Size: Same as connected soil, waste, or vent piping.

2.8 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 - 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 - 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152, of the following minimum weights and thicknesses, unless otherwise indicated:
 - 1. General Applications: 12 oz./sq. ft.
 - 2. Vent Pipe Flashing: 8 oz./sq. ft.
- C. Zinc-Coated Steel Sheet: ASTM A 653, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Install stack air-admittance valves at top of stack vent and vent stack piping.
- I. Install air-admittance-valve wall boxes recessed in wall.
- J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- K. Assemble open drain fittings and install with top of hub 2 inches above floor.
- L. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- O. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- P. Install vent caps on each vent pipe passing through roof.
- Q. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- R. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- T. Install oil-water separator if required, including trapping, venting, and flow-control fitting, according to Owner's drawings, Division 11 of these specifications and manufacturer requirements.
 - 1. Install cleanout immediately downstream from oil-water separator not having integral cleanout on outlet.
- U. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

- V. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.1 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Oil-Water Separators: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic draw-off type unit.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counter-flashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install Owner furnished plastic-laminate equipment nameplate or sign on or near each of the following if applicable:
 - 1. Oil-Water Separator.
 - 2. Oil-Water Lift Sump

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

SECTION 22141 - FACILITY STORM DRAINAGE PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following storm drainage piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sump Pumps."

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.
 - 2. Storm Drainage, Force-Main Piping: 150 psig.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For pipe, tube, fittings, and couplings.
- B. Shop Drawings (if requested by Owner):
 - 1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
 - 2. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
- C. Field quality-control inspection and test reports (if requested by Owner).

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS**2.0 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class/es.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Fernco, Inc.
 - 3) Tyler Pipe; Soil Pipe Div.
 - 2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Tyler Pipe; Soil Pipe Div.
 - 3. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) MG Piping Products Co.
- C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Available Manufacturers:
 - a. ANACO.

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
- C. Pressure Fittings:
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.

4. Cast-Iron Flanges: ASME B16.1, Class 125.
5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125.
- D. Grooved-Joint Systems:
 1. Available Manufacturers:
 - a. Anvil International.
 - b. Victaulic Co. of America.
 2. Grooved-End, Steel-Piping Fittings: ASTM A 47, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.5 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint Systems:
 1. Available Manufacturers:
 - a. Victaulic Co. of America.
 2. Grooved-End, Ductile-Iron Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

2.6 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2.7 ABS PIPE AND FITTINGS

- A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.
- B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.
- C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.8 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.9 SPECIAL PIPE FITTINGS

- A. Flexible, Non-pressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Available Manufacturers:
 - a. Fernco, Inc.
 - b. NDS, Inc.
 - 2. Sleeve Materials:
 - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Non-pressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Rigid, Unshielded, Non-pressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Available Manufacturers:
 - a. ANACO.
- D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - 1. Available Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. JCM Industries, Inc.
 - c. Romac Industries, Inc.
 - d. Viking Johnson.
 - 2. Center-Sleeve Material: Manufacturer's standard.
 - 3. Gasket Material: Natural or synthetic rubber.
 - 4. Metal Component Finish: Corrosion-resistant coating or material.
- E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
 - 1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.
- F. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Available Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products; Star Fittings Div.
- G. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 1. Available Manufacturers:
 - a. SIGMA Corp.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

PART 3 - EXECUTION

3.0 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; standard shielded, stainless-steel couplings; and coupled joints.
 3. Steel pipe, drainage fittings, and threaded joints.
 4. Copper DWV tube, copper drainage fittings, and soldered joints.
 5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 7. Dissimilar Pipe-Material Couplings: Rigid, unshielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.
 3. Steel pipe, drainage fittings, and threaded joints.
 4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 5. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.
 3. Steel pipe, drainage fittings, and threaded joints.
 4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
 5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 6. Dissimilar Pipe-Material Couplings: Rigid, unshielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, cast-iron couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, Sewer and Drain Series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Flexible, Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.2 PIPING INSTALLATION

- A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- D. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- E. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- F. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- K. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- L. Install engineered controlled-flow storm drainage piping in locations indicated.
- M. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- N. Install ABS storm drainage piping according to ASTM D 2661.
- O. Install PVC storm drainage piping according to ASTM D 2665.
- P. Install underground ABS and PVC storm drainage piping according to ASTM D 2321.
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- D. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless coupling joints.
- E. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- F. Grooved Joints: Cut groove ends of pipe and assemble grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings according to AWWA C606.
- G. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - 1. Install gate or full-port ball valve for piping NPS 2 and smaller.
 - 2. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1. Horizontal Piping: Horizontal backwater valves.
 - 2. Install backwater valves in accessible locations.
 - 3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 feet, if indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.

5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
- M. Install supports for vertical ABS and PVC piping every 48 inches.
- N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

SECTION 22142 - STORM DRAINAGE PIPING SPECIALTIES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following storm drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Trench drains.
 - 4. Channel drainage systems.
 - 5. Catch basins.
 - 6. Through-penetration firestop assemblies.
 - 7. Roof drains.
 - 8. Miscellaneous storm drainage piping specialties.
 - 9. Flashing materials.
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves, FOG disposal systems, grease interceptors and removal devices, oil interceptors, and solid interceptors.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.5 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS**2.0 BACKWATER VALVES**

- A. Horizontal, Cast-Iron Backwater Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.14.1.
 3. Size: Same as connected piping.
 4. Body: Cast iron.
 5. Cover: Cast iron with bolted or threaded access check valve.
 6. End Connections: Hub and spigot or hubless.
 7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
 8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Size: Same as floor drain outlet.
 3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
 4. Check Valve: Removable ball float.
 5. Inlet: Threaded.
 6. Outlet: Threaded or spigot.
- C. Horizontal, Plastic Backwater Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. IPS Corporation.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Size: Same as connected piping.
 3. Body: PVC.
 4. Cover: Same material as body with threaded access to check valve.
 5. Check Valve: Removable swing check.
 6. End Connections: Socket type.

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 3. Size: Same as connected drainage piping
 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 5. Closure: Raised-head, cast-iron plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M for adjustable housing cleanout.
 3. Size: Same as connected branch.
 4. Type: Adjustable housing.
 5. Body or Ferrule: Cast iron.
 6. Clamping Device: Required.
 7. Outlet Connection: Threaded.
 8. Closure: Cast-iron plug.
 9. Adjustable Housing Material: Cast iron with threads.
 10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 11. Frame and Cover Shape: Square.
 12. Top Loading Classification: Heavy Duty.
 13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Cast-Iron Wall Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 4. Standard: ASME A112.36.2M. Include wall access.
 5. Size: Same as connected drainage piping.
 6. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 7. Closure: Countersunk, drilled-and-threaded plug.
 8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 9. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 10. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
- D. Plastic Floor Cleanouts:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Zurn Plumbing Products Group; Light Commercial Operation.
 2. Size: Same as connected branch.
 3. Body: PVC.
 4. Closure Plug: PVC.
 5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.2 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Fire-stop Assemblies:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 - 3. Standard: UL 1479 assembly of sleeve and stack fitting with fire-stopping plug.
 - 4. Size: Same as connected pipe.
 - 5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 6. Stack Fitting: ASTM A 48, gray-iron, hubless pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 7. Special Coating: Corrosion resistant on interior of fittings.

2.3 ROOF DRAINS

- A. Metal Roof Drains:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.21.2M.
 - 3. Pattern: Roof drain.
 - 4. Body Material: Cast iron.
 - 5. Combination Flashing Ring and Gravel Stop: Required.
 - 6. Flow-Control Weirs: Not required.
 - 7. Outlet: Bottom.
 - 8. Dome Material: Cast iron.
 - 9. Extension Collars: Required.
 - 10. Underdeck Clamp: Required.
 - 11. Sump Receiver: Not required.
- B. Plastic Roof Drains
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Sioux Chief Manufacturing Company, Inc.
 - b. Zurn Plumbing Products Group; Light Commercial Operation.
 - 2. Standard: ASME A112.21.2M.
 - 3. Pattern: Roof drain.
 - 4. Body Material: ABS or PVC.
 - 5. Combination Flashing Ring and Gravel Stop: Required.
 - 6. Outlet: Bottom.
 - 7. Dome Material: ABS or PVC.
 - 8. Underdeck Clamp: Required.

2.4 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Expansion
 - 1. Standard: ASME A112.21.2M.
 - 2. Body: Cast iron with bronze sleeve, packing, and gland.
 - 3. End Connections: Matching connected piping.
 - 4. Size: Same as connected piping.

2.5 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152, 12 oz./sq. ft. thickness.
- B. Zinc-Coated Steel Sheet: ASTM A 653, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.
- G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- F. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.1 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

SECTION 22330 - DOMESTIC WATER HEATERS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following electric water heaters:
 - 1. Flow-control, instantaneous electric water heaters.
 - 2. Thermostat-control, instantaneous electric water heaters.
 - 3. Commercial, storage electric water heaters.
 - 4. Compression tanks.
 - 5. Instantaneous, tankless, gas water heaters.
 - 6. Commercial, high-efficiency, gas water heaters.
 - 7. Water heater accessories.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings (if requested by Owner): Diagram power, signal, and control wiring.
- C. Product Certificates (if requested by Owner): For each type of commercial and instantaneous electric water heater, signed by product manufacturer.
- D. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Source quality-control test reports (if requested by Owner).
- F. Field quality-control test reports (if requested by Owner).
- G. Operation and Maintenance Data: For electric or gas water heaters to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

- D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Instantaneous Electric Water Heaters: Five year(s).
 - b. Commercial Electric Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.
 - c. Instantaneous, Gas Water Heaters:
 - 1) Heat Exchanger: Five years.
 - 2) Controls and Other Components: Three years.
 - d. Commercial, Gas Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.
 - e. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 INSTANTANEOUS ELECTRIC WATER HEATERS

- A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Available Manufacturers:
 - a. Hot Aqua, Inc.
 - b. IMI Waterheating, Ltd.
 - c. Stiebel Eltron, Inc.
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Flow-control fitting.

- e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
- 3. Support: Bracket for wall mounting.
- 4. Capacity and Characteristics:
 - a. See Drawings.
- B. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Available Manufacturers:
 - a. IMI Waterheating, Ltd.
 - b. Niagara Industries, Inc.
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.
 - 4. Capacity and Characteristics:
 - a. See Drawings.

2.2 INSTANTANEOUS, GAS WATER HEATERS

- A. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
 - 1. Available Manufacturers:
 - a. Rinnai
 - b. NORITZ America Corporation.
 - 2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heat Exchanger: Copper tubing.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1.
 - e. Burner: For use with tankless water heaters and for natural-gas fuel.
 - f. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 - g. Temperature Control: Adjustable thermostat.
 - h. Jacket: Metal with enameled finish or plastic.
 - 3. Support: Bracket for wall mounting.
 - 4. Capacity and Characteristics: See Drawings.

2.3 COMMERCIAL ELECTRIC WATER HEATERS

- A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.
 - 1. Available Manufacturers:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - d. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - e. Smith, A. O. Water Products Company.
 - f. State Industries, Inc.
 - 2. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.

- 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
- b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 1) Staging: Input not exceeding 18 kW per step.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
4. Special Requirements: NSF 5 construction.
5. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
6. Capacity and Characteristics:
 - a. See Drawings.

2.4 COMMERCIAL, GAS WATER HEATERS

- A. Commercial, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.
 1. Available Manufacturers:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - d. Ruud Water Heater Div.; Rheem Manufacturing Company.
 - e. Smith, A. O. Water Products Company.
 - f. State Industries, Inc.
 2. Description: Manufacturer's proprietary design to provide at least 90 percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.
 3. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 4. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.

- c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
- d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
- e. Jacket: Steel with enameled finish.
- f. Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
- 5. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas fuel.
- 6. Temperature Control: Adjustable thermostat.
- 7. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
- 8. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.
- 9. Draft Hood: Draft diverter; complying with ANSI Z21.12.
- 10. Capacity and Characteristics: See Drawings.

2.5 COMPRESSION TANKS

- A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
 - 1. Available Manufacturers:
 - a. AMTROL Inc.
 - b. Smith, A. O.; Aqua-Air Div.
 - c. State Industries, Inc.
 - d. Watts Regulator Co.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics: Per water heater manufacturer's recommendations.

2.4 EXPANSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.
 - 1. Available Manufacturers:
 - a. AMTROL Inc.
 - b. Smith, A. O.; Aqua-Air Div.
 - c. State Industries, Inc.
 - d. Watts Regulator Co.
 - 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - 3. Capacity and Characteristics:
 - a. Per water heater manufacturers recommendations.

2.5 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
- C. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.
- D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- F. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.
- G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.
- H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig maximum outlet pressure, unless otherwise indicated.
- J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.
- K. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.0 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases.
 - 1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
 - 2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install seismic restraints for commercial water heaters. Anchor to substrate.
- D. Install gas water heaters according to NFPA 54.
- E. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-

- heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
 - G. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
 - H. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
 - 2. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.
 - I. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
 - 2. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.
 - J. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
 - K. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
 - L. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
 - M. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
 - N. Install pressure gage(s) on outlet of commercial electric water- heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
 - O. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.
 - P. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
 - Q. Fill water heaters with water.
 - R. Charge compression tanks with air.

3.1 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous water heaters.

SECTION 22400 - PLUMBING FIXTURES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Flushometers.
 - 3. Toilet seats.
 - 4. Fixture supports.
 - 5. Water closets.
 - 6. Urinals.
 - 7. Lavatories.
 - 9. Commercial sinks.
 - 10. Water fountains.
 - 11. Service sinks.
 - 12. Service basins.
- B. Related Sections include the following:
 - Division 10 Section "Toilet Accessories."
 - Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- D. FRP: Fiberglass-reinforced plastic.
- E. PMMA: Polymethyl methacrylate (acrylic) plastic.
- F. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings (if requested by Owner): Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" ; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Plastic Mop-Service Basins: ANSI Z124.6.
 - 3. Plastic Sinks: ANSI Z124.6.
 - 4. Plastic Urinal Fixtures: ANSI Z124.9.
 - 5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
 - 6. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 9. Vitreous-China Fixtures: ASME A112.19.2M.
 - 10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 11. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Faucets: ASME A112.18.1.
 - 4. NSF Potable-Water Materials: NSF 61.
 - 5. Pipe Threads: ASME B1.20.1.
 - 6. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 7. Supply Fittings: ASME A112.18.1.
 - 8. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1.
 - 3. Manual-Operation Flushometers: ASSE 1037.
 - 4. Plastic Tubular Fittings: ASTM F 409.
 - 5. Brass Waste Fittings: ASME A112.18.2.
 - 6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Flexible Water Connectors: ASME A112.18.6.
 - 2. Floor Drains: ASME A112.6.3.
 - 3. Grab Bars: ASTM F 446.
 - 4. Hose-Coupling Threads: ASME B1.20.7.

5. Hot-Water Dispensers: ASSE 1023 and UL 499.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Toilet Seats: ANSI Z124.5.

1.5 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Period for Commercial Applications: One year from date of Certificate of Occupancy.

PART 2 - PRODUCTS

2.0 LAVATORY FAUCETS

- A. Lavatory Faucets:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliant
 - b. Eljer.
 - c. Elkay Manufacturing Co.
 - d. Sloan Valve Company.
 2. Description: Single-control mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 2.2 gpm.
 - d. Maximum Flow: 1.0 gallon.
 - e. Centers: 4 inches.
 - f. Mounting: Deck, concealed.
 - g. Valve Handle(s): Not applicable.
 - h. Inlet(s): NPS 1/2.
 - i. Spout: Rigid type.
 - j. Spout Outlet: Laminar flow.
 - k. Operation: Manual – standard. Sensor – optional.
 - l. Drain: Grid.
- M. Tempering Device: Thermostatic.

2.1 SERVICE SINK FAUCETS

- A. Sink Faucets:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets.
 - b. Eljer.
 - c. Elkay Manufacturing Co.
 - d. T & S Brass and Bronze Works, Inc.
 - e. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
 - d. Mixing Valve: Two-lever handle.
 - e. Backflow Protection Device for Hose Outlet: Required.
 - f. Centers: 8 inches.
 - g. Mounting: back fall
 - h. Handle(s): Wrist blade, 4 inches.
 - i. Inlet(s): NPS 1/2.
 - j. Spout Type: Rigid, solid brass.
 - k. Spout Outlet: Hose thread.
 - l. Vacuum Breaker: Required.
 - m. Operation: Non-compression, manual.
 - n. Drain: Grid.

2.2 FLUSHOMETERS

- A. Flushometers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Plumbing Products Group; Commercial Brass Operation.
 - b. Sloan Valve Company.
 - c. TOTO USA, Inc.
 2. Description: Flushometer for urinal or water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 - a. Internal Design: Diaphragm or piston operation.
 - b. Style: Exposed or Concealed.
 - c. Trip Mechanism: Hard-wired, electric-sensor actuator or Battery-operated sensor actuator.

2.3 TOILET SEATS

- A. Toilet Seats:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bemis Manufacturing Company.
 - c. Church Seats.
 - d. Eljer.
 - e. Olsonite Corp.
 2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic with antimicrobial agent.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: SC, self-sustaining, check.
 - e. Class: Heavy-duty commercial.
 - f. Color: White.

2.4 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGuire Manufacturing Co., Inc.
 - b. TCI Products.
 - c. TRUEBRO, Inc.
 - d. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.5 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
 2. Smith, Jay R. Mfg. Co.
 3. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 4. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Urinal Supports:
1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
 2. Wall mounted.
 3. Accessible-Fixture Support: Include rectangular steel uprights.
- C. Lavatory Supports:
1. Description: Type I, lavatory carrier with exposed arms and tie rods for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
 2. Accessible-Fixture Support: Include rectangular steel uprights.
- D. Sink Supports:
1. Description: Type I, sink carrier with exposed arms and tie rods for sink-type fixture. Include steel uprights with feet.
 2. Floating sink.

2.6 WATER CLOSETS

- A. Water Closets:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Eljer.
 - c. Kohler Co.
 - d. Crane
 2. Description: Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Style: Flushometer valve.
 - 1) Flush: Standard.
 - 2) Auto flush: Optional.
 - 3) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - 4) Height: Standard.

- 5) Design Consumption: 1.6 gal./flush.
- 6) Color: White.
- B. Water Closets:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eljer.
 - b. Kohler Co.
 - c. American Standard Companies, Inc.
 - d. Crane
 - 2. Description Accessible, floor-mounting, back-outlet, vitreous-china fixture designed for flushometer-valve operation.
 - a. Style: Flushometer valve.
 - 1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - 2) Height: Accessible.
 - 3) Design Consumption: 1.6 gal./flush.
 - 4) Color: White.

2.7 URINALS

- A. Urinals:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Eljer.
 - d. Kohler Co.
 - e. Crane
 - 2. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Type: Siphon jet.
 - b. Strainer or Trapway: Separate removable strainer with integral trap.
 - c. Design Consumption: 1 gal./flush.
 - d. Color: White.
 - e. Fixture Support: Urinal chair carrier.

2.8 LAVATORY

- A. Commercial Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eljer
 - b. Elkay Manufacturing Co.
 - c. Crane
 - d. American Standard Companies, Inc.
 - 2. Description: One-compartment, wall-hung, stainless-steel commercial sink with backsplash.
 - a. Compartment:
 - 1) Drain: Grid with NPS 1-1/2 tailpiece and twist drain.
 - a) Location: Centered in compartment.
 - b. Faucet(s): Sink.
 - 1) Number Required: One.
 - 2) Mounting: Backsplash.
 - b. Supplies: NPS 3/4 chrome-plated copper with stops or PVC shutoff valves.
 - c. Drain Piping: NPS 2 and wall escutcheon(s).
- B. Commercial Sinks ADA Compliant:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eljer
 - b. Elkay Manufacturing Co.
 - c. Crane
 - d. American Standard Companies, Inc.
2. Description: One-compartment, wall-hung, cast-iron ceramic lavatory with backsplash.
 - a. Compartment:
 - 1) Drain: Grid with NPS 1-1/2 tailpiece and twist drain.
 - a) Location: Centered in compartment.
 - b. Faucet(s): Sink.
 - 1) Number Required: One.
 - 2) Mounting: Backsplash.
 - c. Supplies: NPS 3/4 chrome-plated copper with stops or PVC shutoff valves.
 - d. Drain Piping: NPS 2 and wall escutcheon(s).

2.9 SERVICE BASINS

- A. Service Sink:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Florestone Products Co., Inc.
 - c. Swan Corporation.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 - e. American Standard Industries, Inc.
 2. Description: Flush-to-wall, floor-mounting, enameled cast-iron with rim guard.
 - a. Shape: Square.
 - b. Size: 24 by 20 inches.
 - c. Height: 10 inches.
 - e. Color: White.
 - f. Faucet: Sink.
 - g. 3" Waste
- B. Mop Sink
 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - a. Fiat
 2. Description
 - a. Shape: Square.
 - b. Size: 23 by 22 inches.
 - c. Capacity: 20 gallons
 - e. Color: White.
 - f. Fiberglass
 - g. Faucet: Deck type
 - h. 2" Waste

2.10 EYEWASH

- A. Eyewash Manufacturer: Guardian model G1825HFCHSDCP
 1. Description:
 - a. Pedestal mounted
 - b. Safety Orange ABS Plastic Bowl
 - c. Plated Brass Supply Arms
 - d. ANSI compliant identification sign
 - e. Auxiliary hand-held drench hose

- f. Protective head covers
 - g. Two fine spray heads
- B. Mixing valve Manufacturer: Lawler 911E/F
 - 1. Description:
 - a. Thermostatic to provide 85 degree F water to eyewash.
 - b. Hot water port control mechanism
 - c. Max. inlet pressure 125 psi.
 - d. ½" connections
 - e. 7 gpm at 30 psi.
 - f. Liquid filled thermostat

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- L. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- M. Install toilet seats on water closets.
- N. Install trap-seal liquid in dry urinals.
- O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

- P. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- Q. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
- T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- U. Set Mop Sink in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- V. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms when used.
- E. Test eyewash for proper operation.

3.5 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.6 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.
- C. Check ADA clearances.

SECTION 23050 - COMMON WORK RESULTS FOR HVAC**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Painting and finishing.
 - 10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PE: Polyethylene plastic.
 - 3. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates (if requested by Owner).

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight and support to prevent sagging and bending.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS**2.0 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - a.. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.3 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Available Manufacturers:
 - a. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Available Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 - 1. Available Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 - 1. Available Manufacturers:
 - a. Epco Sales, Inc.

- b. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Central Plastics Company.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Metraflex Co.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION**3.0 HVAC DEMOLITION**

- A. Refer to Division 01 Section "Project Coordination" and Division 02 Section "Demolition" for general demolition requirements and procedures.
- B. If applicable, disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.1 PIPING SYSTEMS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping: Use the following:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. PVC Pipe Sleeves: For pipes smaller than NPS 6.

- b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
- 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position the pipe in the center of the sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position the pipe in the center of the sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Refer to Division 07 Section "Penetration Fire-stopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846 Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install the HVAC equipment to facilitate servicing and maintenance of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

SECTION 23051 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS**2.0 GENERAL MOTOR REQUIREMENTS**

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.1 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.2 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- D. Multi-speed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Greasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.

- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

2.3 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Variable Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.4 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multi-speed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

Not Applicable

SECTION 23052 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal-bellows expansion joints.
 - 2. Expansion compensators.
 - 3. Rubber expansion joints.
 - 4. Flexible-hose expansion joints.
 - 5. Packed slip expansion joints.
 - 6. Flexible ball joints.
 - 7. Pipe bends and loops.
 - 8. Alignment guides and anchors.

1.2 DEFINITIONS

- A. BR: Butyl rubber.
- B. Buna-N: Nitrile rubber.
- C. CR: Chlorosulfonated polyethylene synthetic rubber.
- D. CSM: Chlorosulfonyl-polyethylene rubber.
- E. EPDM: Ethylene-propylene-diene terpolymer rubber.
- F. NR: Natural rubber.
- G. PTFE: Polytetrafluoroethylene plastic.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
- B. Delegated-Design Submittal (if requested by Owner): For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates (if requested by Owner).
- D. Product Certificates (if requested by Owner): For each type of pipe expansion joint, signed by product manufacturer.
- E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
 - 2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS**2.0 EXPANSION JOINTS**

- A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Expansion Joint Systems, Inc.
 - b. Flex-Weld, Inc.
 - c. Metraflex, Inc.
 - d. Unaflex Inc.
 - 2. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
 - 3. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
 - 4. Metal-Bellows Expansion Joints for Steel Piping: Single- or multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
 - 5. Minimum Pressure Rating: 175 psig, unless otherwise indicated.
 - 6. Configuration: Single- or double-bellows type, unless otherwise indicated.
 - 7. End Connections: Flanged or weld.
- B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, anti-torque device, and removable end clip for positioning.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flex-Pression, Ltd.
 - b. Metraflex, Inc.
 - c. Unaflex Inc.
 - 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
 - 3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
 - 4. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
 - 5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 - 6. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
 - 7. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - 8. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged or threaded.
- C. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flexicraft Industries.
 - b. Metraflex, Inc.
 - c. Unaflex Inc.
 - 2. Arch Type: Single or multiple arches.
 - 3. Spherical Type: Single or multiple spheres.
 - a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
 - b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6: 140 psig at 200 deg F.
 - c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12: 140 psig at 180 deg F.
 - 4. Material: EPDM.
 - 5. End Connections: Full-faced, integral, steel flanges with steel retaining rings.
- D. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex-Pression, Ltd.

- d. Metraflex, Inc.
- 2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
- 3. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder joint end connections.
 - a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 - b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
- 4. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
 - a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
- 5. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged end connections for NPS 2-1/2 and larger.
 - a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 - b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
 - c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- E. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Adscos Manufacturing, LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Hyspan Precision Products, Inc.
 - 2. Configuration: Single- and double-joint class.
 - 3. End Connections: Flanged or weld ends to match piping system.
- F. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials," and with ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
 - 1. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
 - 2. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
 - 3. End Connections for NPS 2 and Smaller: Threaded.
 - 4. End Connections for NPS 2-1/2 and Larger: Flanged.
 - 5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advanced Thermal Systems, Inc.
 - b. Hyspan Precision Products, Inc.

2.1 ALIGNMENT GUIDES

- A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advanced Thermal Systems, Inc.
 - b. Flexicraft Industries.
 - c. Metraflex, Inc.
 - d. Piping Technology & Products, Inc.

2.2 MATERIALS FOR ANCHORS

- A. Steel Shapes and Plates: ASTM A 36.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Stud: Threaded, zinc-coated carbon steel.
 - 2. Expansion Plug: Zinc-coated steel.
 - 3. Washer and Nut: Zinc-coated steel.
- E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
 - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.0 EXPANSION-JOINT INSTALLATION

- A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
- B. Install expansion joints of sizes matching size of piping in which they are installed.
- C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.1 PIPE BEND AND LOOP INSTALLATION

- A. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.2 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE INSTALLATION

- A. Install guides on piping adjoining pipe expansion fittings and loops.
- B. Attach guides to pipe and secure to building structure.

3.4 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.
- E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

SECTION 23053 – GENERAL DUTY VALVES FOR HVAC PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Bronze angle valves.
 - 2. Brass ball valves.
 - 3. Bronze ball valves.
 - 4. Iron ball valves.
 - 5. Iron, single-flange butterfly valves.
 - 6. Iron, grooved-end butterfly valves.
 - 7. High-performance butterfly valves.
 - 8. Bronze lift check valves.
 - 9. Bronze swing check valves.
 - 10. Iron swing check valves.
 - 11. Iron swing check valves with closure control.
 - 12. Iron, grooved-end swing-check valves.
 - 13. Iron, center-guided check valves.
 - 14. Iron, plate-type check valves.
 - 15. Bronze gate valves.
 - 16. Iron gate valves.
 - 17. Bronze globe valves.
 - 18. Iron globe valves.
 - 19. Lubricated plug valves.
 - 20. Eccentric plug valves.
- B. Related Sections:
 - 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
 - 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of valve indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use hand-wheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.0 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 2. Hand-wheel: For valves other than half-turn types.
 3. Hand-lever: For quarter and half turn valves NPS 6 and smaller except plug valves.
 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Grooved: With grooves according to AWWA C606.
 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.1 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Bronze Disc:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

- d. Ends: Threaded.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Hand-wheel: Malleable iron.
- B. Class 125, Bronze Angle Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.
- C. Class 150, Bronze Angle Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Stockham Division.
 - b. Kitz Corporation.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Hand-wheel: Malleable iron.
- D. Class 150, Bronze Angle Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - 2. Description:

- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- B. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- C. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Legend Valve.
 - b. Marwin Valve; a division of Richards Industries.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.
- D. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jamesbury; a subsidiary of Metso Automation.
 - b. Marwin Valve; a division of Richards Industries.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Brass or bronze.
 - f. Ends: Threaded.

- g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Regular.
- E. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three-piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- F. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - b. Marwin Valve; a division of Richards Industries.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three-piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Legend Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.

- h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- B. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- C. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.
- D. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Jenkins Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Regular.
- E. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- F. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three-piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.4 IRON BALL VALVES

- A. Class 125, Iron Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Split body.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Ends: Flanged.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- C. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- D. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.

- b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- E. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- F. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- G. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.

- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - h. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- I. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- J. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.

- e. NIBCO INC.
- f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- K. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- L. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.

2.6 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Tyco Fire Products LP; Grinnell Mechanical Products.
 - b. Victaulic Company.
 - 2. Description:

- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.
- B. 300 CWP, Iron, Grooved-End Butterfly Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. NIBCO INC.
 - c. Tyco Fire Products LP; Grinnell Mechanical Products.
 - d. Victaulic Company.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. NPS 10 and Larger CWP Rating: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

2.7 HIGH-PERFORMANCE BUTTERFLY VALVES

- A. Class 150, Single-Flange, High-Performance Butterfly Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.
- B. Class 300, Single-Flange, High-Performance Butterfly Valves:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 720 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, or ductile iron.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.

- g. Disc: Carbon steel.
- h. Service: Bidirectional.

2.8 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 125, Lift Check Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kitz Corporation.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.

2.9 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.
- C. Class 150, Bronze Swing Check Valves with Bronze Disc:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.10 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Kitz Corporation.
 - c. Legend Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

- B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Composition.
 - h. Seat Ring: Bronze.
 - i. Disc Holder: Bronze.
 - j. Disc: PTFE or TFE.
 - k. Gasket: Asbestos free.
- C. Class 250, Iron Swing Check Valves with Metal Seats:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

2.11 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125, Iron Swing Check Valves with Lever and Spring-Closure Control:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and spring.
- B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and weight.

2.12 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP, Iron, Grooved-End Swing Check Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire Products LP; Grinnell Mechanical Products.
 - c. Victaulic Company.
 2. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A 536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring operated, ductile iron or stainless steel.

2.13 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Compact wafer.
 - f. Seat: Bronze.
- B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- C. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- D. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.
- E. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milwaukee Valve Company.
 - b. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.

2.14 IRON, PLATE-TYPE CHECK VALVES

- A. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - f. Seat: Bronze.
- B. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 126, gray iron.
 - f. Seat: Bronze.
- C. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - f. Seat: Bronze.
- D. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. NIBCO INC.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 126, gray iron.
 - f. Seat: EPDM or NBR.
- E. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 395 or ASTM A 536, ductile iron.
 - f. Seat: EPDM or NBR.
- F. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - 2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A 126, gray iron.
 - f. Seat: EPDM or NBR.

2.15 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.
- B. Class 125, RS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.
- C. Class 150, NRS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.
- D. Class 150, RS Bronze Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.

2.16 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- C. Class 250, NRS, Iron Gate Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet
 - e. Ends: Flanged.

- f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- D. Class 250, OS&Y, Iron Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.17 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Hand-wheel: Malleable iron.
- B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.
- C. Class 150, Bronze Globe Valves with Nonmetallic Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.

- c. NIBCO INC.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Hand-wheel: Malleable iron.

2.18 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.
- B. Class 250, Iron Globe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.19 LUBRICATED PLUG VALVES

- A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Venturi.

- f. Plug: Cast iron or bronze with sealant groove.
- B. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milliken Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Venturi.
 - f. Plug: Cast iron or bronze with sealant groove.
- C. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nordstrom Valves, Inc.
 - 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Venturi.
 - f. Plug: Cast iron or bronze with sealant groove.
- D. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milliken Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 48 or ASTM A 126, cast iron with lubrication-sealing system.
 - e. Pattern: Venturi.
 - f. Plug: Cast iron or bronze with sealant groove.

2.20 ECCENTRIC PLUG VALVES

- A. 175 CWP, Eccentric Plug Valves with Resilient Seating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Milliken Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-108.
 - b. CWP Rating: 175 psig minimum.
 - c. Body and Plug: ASTM A 48, gray iron; ASTM A 126, gray iron; or ASTM A 536, ductile iron.
 - d. Bearings: Oil-impregnated bronze or stainless steel.
 - e. Ends: Flanged.
 - f. Stem-Seal Packing: Asbestos free.
 - g. Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

PART 3 - EXECUTION**3.0 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.1 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.2 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service except Steam: Globe, ball, or butterfly valves.
 - 4. Throttling Service, Steam: Globe or angle valves.
 - 5. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

SECTION 23054 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fiberglass pipe hangers.
 - 4. Metal framing systems.
 - 5. Fiberglass strut systems.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Equipment supports.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
 - 3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 5. Division 23 Sections "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry, Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Fiberglass pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Powder-actuated fastener systems.

- B. Shop Drawings (if requested by Owner): Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Welding certificates (if requested by Owner).

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Grinnell Corp.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Unistrut Corp.; Tyco International, Ltd.

- B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.
 - 1. Manufacturers:
 - a. Plasti-Fab, Inc.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-4, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Thomas & Betts Corporation.
 - 3. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 FIBERGLASS STRUT SYSTEMS

- A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-4, made of fiberglass channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Cope, T. J., Inc.; Tyco International Ltd.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Pipe Shields, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.

2.8 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, non-corrosive, and non-gaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.0 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 - 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 - 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.1 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- P. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood inserts.
 6. Insert Material: Length at least as long as protective shield.
 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- 1. Refer to Division 09 Painting Sections.

SECTION 23055 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Freestanding and restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Freestanding and restrained air-mounting system.
 - 12. Restrained vibration isolation roof-curb rails.
 - 13. Seismic snubbers.
 - 14. Restraining braces and cables.
 - 15. Steel and inertia, vibration isolation equipment bases.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. In accordance with code and acceptable to the authority having jurisdiction.
- B. Seismic-Restraint Loading:
 - 1. In accordance with code and acceptable to the authority having jurisdiction.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

- B. Delegated-Design Submittal (if requested by Owner): For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 - 4. Seismic and Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 22 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Coordination Drawings (if requested by Owner): Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates (if requested by Owner).
- E. Qualification Data (if requested by Owner): For professional engineer and testing agency.
- F. Air-Mounting System Performance Certification (if requested by Owner): Include natural frequency, load, and damping test data performed by an independent agency.
- G. Field quality-control test reports (if requested by Owner).
- H. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-approval by another agency acceptable to authorities having jurisdiction, showing

maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.0 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
 - 1. California Dynamics Corporation.
 - 2. Mason Industries.
 - 3. Vibration Eliminator Co., Inc.
- D. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel base-plates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- E. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with base-plate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- F. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- G. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Base-plates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to base-plate underside. Base-plates shall limit floor load to 500 psig.
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- H. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled base-plate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to base-plate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- I. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
 1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.
- J. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- K. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- L. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- M. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

- N. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and replaceable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.1 AIR-MOUNTING SYSTEMS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. California Dynamics Corporation.
 - 2. Vibration Eliminator Co., Inc.
- D. Air Mounts: Freestanding, single or multiple, compressed-air bellows.
 - 1. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows.
 - 2. Maximum Natural Frequency: 3 Hz.
 - 3. Operating Pressure Range: 25 to 100 psig.
 - 4. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 5. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch.
- E. Restrained Air Mounts: Housed compressed-air bellows.
 - 1. Assembly: Upper and lower steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows and spring, with angle-iron frame having vertical-limit stops and channel-section top with leveling adjustment and attachment screws.
 - 2. Maximum Natural Frequency: 3 Hz.
 - 3. Operating Pressure Range: 25 to 100 psig.
 - 4. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - 5. Leveling Valves: Minimum of 3 required to maintain leveling within plus or minus 1/8 inch.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. California Dynamics Corporation.
 - 2. Thybar Corporation.
 - 3. Vibration Eliminator Co., Inc.
- D. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- E. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

- F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or wind restraint.
 - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a non-slip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - a. Resilient Material: Oil and water resistant standard neoprene.
- G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- H. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. California Dynamics Corporation.
 - 2. Vibration Eliminator Co., Inc.
- D. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- E. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 1. California Dynamics Corporation.
 2. Hilti, Inc.
 3. Unistrut; Tyco International, Ltd.
- D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- E. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch thick resilient cushion.
- F. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- G. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- H. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- I. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- J. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- L. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- M. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic and wind control devices to indicate capacity range.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- D. Install cables so they do not bend across edges of adjacent equipment or building structure.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

- G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- I. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Hydronic Piping" for piping flexible connections.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
 - 11. Test and adjust air-mounting system controls and safeties.

12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust the isolators after the piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems.

SECTION 23056 - TESTING, ADJUSTING AND BALANCING FOR HVAC**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Dual-duct systems.
 - c. Variable-air-volume systems.
 - d. Multizone systems.
 - e. Induction-unit systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary-secondary hydronic systems.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

- A. Qualification Data (if requested by Owner): Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report (if requested by Owner): Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan (if requested by Owner): Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports (if requested by Owner).
- E. Sample report forms (if requested by Owner).
- F. Instrument calibration reports, to include the following (if requested by Owner):
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Area Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by the Engineer of Record.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.5 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

- E. Examine ceiling plenums and under-floor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts and Nonmetal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.1 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE 111 and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.4 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure the airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Engineer of Record for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure the amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.5 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.

3.6 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.7 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 1. Supply and Return Fans: Zero to plus 10 percent.
 2. Exhaust and Equipment with Fans: Zero to plus 10 percent..
 3. Air Outlets and Inlets: Plus or minus 10 percent.

3.8 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.

- h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Pipe and valve sizes and locations.
 - 4. Balancing stations.
 - 5. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outdoor-air damper position.
 - k. Return-air damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.

- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Refrigerant expansion valve and refrigerant types.
 - i. Refrigerant suction pressure in psig.
 - j. Refrigerant suction temperature in deg F.
- G. Gas Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft.
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.

- c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- K. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.10 INSPECTIONS

- A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner's Representative.
 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner's Representative.
 3. Owner's representative may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports. Submit to General Contractor and Owner

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

SECTION 23070 - HVAC INSULATION**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - e. Fire-rated insulation systems.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Mastics.
 - 5. Lagging adhesives.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Tapes.
 - 9. Securements.
 - 10. Corner angles.
- B. Related Sections:
 - 1. Division 21 Section "Fire-Suppression Systems Insulation."
 - 2. Division 22 Section "Plumbing Insulation."
 - 3. Division 23 Section "Metal Ducts" for duct liners.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings (if requested by Owner):
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Qualification Data (if requested by Owner): For qualified Installer.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for application of piping insulation duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing if applicable.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.0 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Industrial Insulation Group; Thermo-12 Gold.
 - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; AP Armaflex.
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Owens Corning; All-Service Duct Wrap.
- J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Owens Corning; Fiberglas 700 Series.
- K. Mineral-Fiber, Preformed Pipe Insulation:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
- L. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
- M. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.1 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Thermal Ceramics; FireMaster Duct Wrap.
 - b. Unifrax Corporation; FyreWrap.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-97.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
 - c. Marathon Industries, Inc.; 290.
 - d. Vimasco Corporation; 760.
- C. Cellular-Glass, Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ITW TACC, Division of Illinois Tool Works; CB-50.
 - b. Marathon Industries, Inc.; 590.
 - c. Mon-Eco Industries, Inc.; 55-40.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Vimasco Corporation; 136.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Vimasco Corporation; 750.
 2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - d. Vimasco Corporation; 750.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: Minus 100 to plus 300 deg F.
 6. Color: White or gray.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, Kraft paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.7 TAPES

- A. ASJ Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor retarder tape with acrylic adhesive.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

- A. Bands:
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Insulation Pins and Hangers:
 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CWP-1.

- 2) GEMCO; CD.
- 3) Midwest Fasteners, Inc.; CD.
- 4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base-plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Base-plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Base-plate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Base-plate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Base-plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
 - 2) GEMCO; Press and Peel.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Base-plate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. C & F Wire.
 - b. Childers Products.

2.9 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing if applicable. Comply with requirements for heat tracing installation that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry the surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.

3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 1. Comply with requirements in Division 07 Section "Penetration Fire-stopping" and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Pipe: Install insulation continuously through floor penetrations.
 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Fire-stopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted

- tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape any PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement

applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 CALCIUM SILICATE INSULATION INSTALLATION

- A. Insulation Installation on Boiler Breechings and Ducts:
 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 3. On exposed applications without metal jacket, finish the insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
- B. Insulation Installation on Straight Pipes and Tubes:
 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- C. Insulation Installation on Pipe Flanges:
 1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 4. Finish flange insulation same as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 3. Finish fittings insulation same as pipe insulation.
- E. Insulation Installation on Valves and Pipe Specialties:
 1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 2. Install insulation to flanges as specified for flange insulation application.
 3. Finish valve and specialty insulation same as pipe insulation.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

3.7 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions; where access to top of ductwork is limited, adhesive application to top of ductwork may be omitted.
3. Install capacitor discharge weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space the pins 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap un-faced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions; where access to top of ductwork is limited, adhesive application to top of ductwork may be omitted..

3. Install capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space the pins 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install fire-stopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Fire-stopping."

3.9 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 1. Indoor, concealed supply and outdoor air.
 2. Indoor, exposed supply and outdoor air.
 3. Indoor, concealed return located in non-conditioned space.
 4. Indoor, exposed return located in non-conditioned space.
 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 7. Outdoor, concealed supply and return.
 8. Outdoor, exposed supply and return.

- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inches thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick

SECTION 23112 - FACILITY NATURAL-GAS PIPING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Service meters.
 - 7. Mechanical sleeve seals.
 - 8. Grout.
 - 9. Concrete bases.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, etc.
- B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 65 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.
- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars.
 - 6. Dielectric fittings.
 - 7. Mechanical sleeve seals.
 - 8. Escutcheons.
- B. Shop Drawings(if requested by Owner): For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors,

hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal (if requested by Owner): For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Detail fabrication and assembly of seismic restraints.
 2. Design Calculations: Calculate requirements for selecting seismic restraints.
- D. Coordination Drawings (if requested by Owner): Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- F. Qualification Data (if requested by Owner): For qualified professional engineer.
- G. Welding certificates (if requested by Owner).
- H. Field quality-control reports (if requested by Owner).
- I. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.7 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS**2.0 PIPES, TUBES, AND FITTINGS**

- A. Steel Pipe: ASTM A 53, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234 for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 - 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 - 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 - 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 - 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 - 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 - 5. Striker Plates: Steel, designed to protect tubing from penetrations.

6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: 5 psig.
- C. Aluminum Tubing: Comply with ASTM B 210 and ASTM B 241.
 1. Aluminum Alloy: Alloy 5456 is prohibited.
 2. Protective Coating: Factory-applied coating capable of resisting corrosion on tubing in contact with masonry, plaster, insulation, water, detergents, and sewerage.
 3. Flare Fittings: Comply with ASME B16.26 and SAE J513.
 - a. Copper-alloy fittings.
 - b. Metal-to-metal compression seal without gasket.
 - c. Dryseal threads shall comply with ASME B1.20.3.
- D. PE Pipe: ASTM D 2513, SDR 11.
 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53, black steel, Schedule 40, Type E or S, Grade B.
 3. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
 5. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.
 6. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

- a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
- b. Steel flanges and tube with epoxy finish.
- c. Buna-nitrile seals.
- d. Steel bolts, washers, and nuts.
- e. Factory-installed anode for steel-body couplings installed underground.

2.1 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
 - 4. Corrugated stainless-steel tubing with polymer coating.
 - 5. Operating-Pressure Rating: 0.5 psig.
 - 6. End Fittings: Zinc-coated steel.
 - 7. Threaded Ends: Comply with ASME B1.20.1.
 - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Nitrile seals.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- D. Basket Strainers:
 - 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 60 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- E. T-Pattern Strainers:
 - 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 - 2. End Connections: Grooved ends.
 - 3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 - 4. CWP Rating: 750 psig.
- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.3 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.
 - 3. Ball: Chrome-plated bronze.
 - 4. Stem: Bronze; blowout proof.
 - 5. Seats: Reinforced TFE; blowout proof.
 - 6. Packing: Threaded-body pack-nut design with adjustable-stem packing.
 - 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 8. CWP Rating: 600 psig.
 - 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Cast-Iron, Non-lubricated Plug Valves: MSS SP-78.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. McDonald, A. Y. Mfg. Co.
 - b. Mueller Co.; Gas Products Div.
 - c. Xomox Corporation; a Crane company.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron Lubricated Plug Valves: MSS SP-78.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. PE Ball Valves: Comply with ASME B16.40.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Kerotest Manufacturing Corp.

- b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: PE.
- 3. Ball: PE.
- 4. Stem: Acetal.
- 5. Seats and Seals: Nitrile.
- 6. Ends: Plain or fusible to match piping.
- 7. CWP Rating: 80 psig.
- 8. Operating Temperature: Minus 20 to plus 140 deg F.
- 9. Operator: Nut or flat head for key operation.
- 10. Include plastic valve extension.
- 11. Include tamperproof locking feature for valves where indicated on Drawings.
- I. Valve Boxes:
 - 1. Cast-iron, two-section box.
 - 2. Top section with cover with "GAS" lettering.
 - 3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
 - 4. Adjustable cast-iron extensions of length required for depth of bury.
 - 5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.4 MOTORIZED GAS VALVES

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Honeywell International Inc.
 - b. Johnson Controls.
 - 3. Body: Brass or aluminum.
 - 4. Seats and Disc: Nitrile rubber.
 - 5. Springs and Valve Trim: Stainless steel.
 - 6. Normally closed.
 - 7. Visual position indicator.
 - 8. Electrical operator for actuation by appliance automatic shutoff device.
- B. Electrically Operated Valves: Comply with UL 429.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Magnatrol Valve Corporation.
 - b. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - 2. Pilot operated.
 - 3. Body: Brass or aluminum.
 - 4. Seats and Disc: Nitrile rubber.
 - 5. Springs and Valve Trim: Stainless steel.
 - 6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
 - 7. NEMA ICS 6, Type 4, coil enclosure.
 - 8. Normally closed.
 - 9. Visual position indicator.

2.5 EARTHQUAKE VALVES

- A. Earthquake Valves: Comply with ASCE 25.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pacific Seismic Products, Inc.
 - 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 3. Maximum Operating Pressure: 7 psig.
 - 4. Cast-aluminum body with stainless-steel internal parts.
 - 5. Nitrile-rubber, reset-stem o-ring seal.
 - 6. Valve position, open or closed, indicator.
 - 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
 - 8. Level indicator.
 - 9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.6 PRESSURE REGULATORS

- A. General Requirements:
 - 1. Single stage and suitable for natural gas.
 - 2. Steel jacket and corrosion-resistant components.
 - 3. Elevation compensator.
 - 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Service Pressure Regulators: Comply with ANSI Z21.80.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Invensys.
 - 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 - 3. Springs: Zinc-plated steel; interchangeable.
 - 4. Diaphragm Plate: Zinc-plated steel.
 - 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 - 6. Orifice: Aluminum; interchangeable.
 - 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 - 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 - 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 - 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 - 12. Maximum Inlet Pressure: 100 psig.
- C. Line Pressure Regulators: Comply with ANSI Z21.80.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Invensys.

- d. Maxitrol Company.
 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 10. Overpressure Protection Device: Factory mounted on pressure regulator.
 11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
 12. Maximum Inlet Pressure: 2 psig.
- D. Appliance Pressure Regulators: Comply with ANSI Z21.18.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Maxitrol Company.
 2. Body and Diaphragm Case: Die-cast aluminum.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
 9. Maximum Inlet Pressure: 1 psig.

2.7 SERVICE METERS

- A. Diaphragm-Type Service Meters: Comply with ANSI B109.2.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Invensys.
 2. Case: Die-cast aluminum.
 3. Connections: Steel threads.
 4. Diaphragm: Synthetic fabric.
 5. Diaphragm Support Bearings: Self-lubricating.
 6. Compensation: Continuous temperature and pressure.
 7. Meter Index: Cubic feet.
 8. Meter Case and Index: Tamper resistant.
 9. Remote meter reader compatible.
 10. Maximum Inlet Pressure: 100 psig.
 11. Pressure Loss: Maximum 0.5-inch wg.
 12. Accuracy: Maximum plus or minus 1.0 percent.
- B. Rotary-Type Service Meters: Comply with ANSI B109.3.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Invensys.

2. Case: Extruded aluminum.
 3. Connection: Flange.
 4. Impellers: Polished aluminum.
 5. Rotor Bearings: Self-lubricating.
 6. Compensation: Continuous temperature and pressure.
 7. Meter Index: Cubic feet.
 8. Tamper resistant.
 9. Remote meter reader compatible.
 10. Maximum Inlet Pressure: 100 psig.
 11. Accuracy: Maximum plus or minus 2.0 percent.
- C. Service-Meter Bars:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Meter Company.
 - b. Lyall, R. W. & Company, Inc.
 2. Malleable- or cast-iron frame for supporting service meter.
 3. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
 4. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.
- D. Service-Meter Bypass Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lyall, R. W. & Company, Inc.
 - b. Williamson, T. D., Inc.
 2. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
 3. Integral ball-check bypass valve.

2.8 DIELECTRIC FITTINGS

- A. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - b. Wilkins; Zurn Plumbing Products Group.
 2. Minimum Operating-Pressure Rating: 150 psig.
 3. Combination fitting of copper alloy and ferrous materials.
 4. Insulating materials suitable for natural gas.
 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- B. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - b. Wilkins; Zurn Plumbing Products Group.
 2. Minimum Operating-Pressure Rating: 150 psig.
 3. Combination fitting of copper alloy and ferrous materials.
 4. Insulating materials suitable for natural gas.
 5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.9 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.

2.10 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Metraflex Company.
 - b. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.11 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated or rough brass.
- D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated or rough brass.
- E. One-Piece, Stamped-Steel Escutcheons: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Escutcheons: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.
- G. One-Piece, Floor-Plate Escutcheons: Cast-iron floor plate.
- H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.12 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.13 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION**3.0 EXAMINATION**

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 or the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 or the International Fuel Gas Code requirements for prevention of accidental ignition.

3.2 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 or the International Fuel Gas Code acceptable to the authority having jurisdiction for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe.
- E. Install fittings for changes in direction and branch connections.
- F. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
- G. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- H. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- I. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.3 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 or the International Fuel Gas Code acceptable to the authority having jurisdiction for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate

- friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
 - D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 - E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - G. Locate valves for easy access.
 - H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
 - I. Install piping free of sags and bends.
 - J. Install fittings for changes in direction and branch connections.
 - K. Install escutcheons at penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - d. Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
 - e. Piping in Equipment Rooms: One-piece, cast-brass type.
 - f. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Existing Piping:
 - a. Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - b. Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - c. Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
 - d. Piping in Equipment Rooms: Split-casting, cast-brass type.
 - e. Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
 - L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire-stop materials. Comply with requirements in Division 07 Section "Penetration Fire-stopping."
 - M. Verify final equipment locations for roughing-in.
 - N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
 - O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
 - P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
 - Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
 - R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- T. Connect branch piping from top or side of horizontal piping.
- U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- V. Do not use natural-gas piping as grounding electrode.
- W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- X. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground.
- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies if required. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.

- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Braze Joints: Construct joints according to AWS's "Braze Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not over-tighten.
- H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- D. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.

- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Topcoat: Interior latex (flat).
 - c. Color: Gray.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Topcoat: Interior alkyd (flat).
 - c. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Use 3000-psi, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 or the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be one of the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
 - 2. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- C. Underground, below building, piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat the pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat the underground pipe and fittings with protective coating for steel piping.

3.16 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.
 - 3. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.17 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.
 - 2. Two-piece, regular-port, bronze ball valves with bronze trim.
 - 3. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.
 - 3. Cast-iron, non-lubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. One-piece, bronze ball valve with bronze trim.

2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
 3. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

SECTION 23311 - METAL DUCTS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Supplementary Conditions and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
1. Single-wall rectangular ducts and fittings.
 2. Single-wall round and flat-oval ducts and fittings.
 3. Sheet metal materials.
 4. Duct liner.
 5. Sealants and gaskets.
 6. Hangers and supports.
 7. Seismic-restraint devices.
- B. Related Sections:
1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
 3. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of the following products:
1. Liners and adhesives.
 2. Sealants and gaskets.
 3. Seismic-restraint devices.
- B. Shop Drawings (if requested by Owner):
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 2. Factory- and shop-fabricated ducts and fittings.
 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 4. Elevation of top of ducts.
 5. Dimensions of main duct runs from building grid lines.
 6. Fittings.
 7. Reinforcement and spacing.

8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment , seismic restraints, and vibration isolation.
- C. Delegated-Design Submittal (if requested by Owner):
 1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 5. Design Calculations: Calculations , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.
- D. Coordination Drawings (if requested by Owner): Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- E. Welding certificates (if requested by Owner).
- F. Field quality-control reports (if requested by Owner).

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.0 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support

- intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.1 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Lindab Inc.
 - b. SEMCO Incorporated.
 - c. Sheet Metal Connectors, Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

- C. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - e. Maximum Thermal Conductivity:
 - 1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bonded Logic, Inc.
 - b. Reflectix Inc.
 - 2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
 - 3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E 84; certified by an NRTL.
 - 4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 - 6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 - 7. Secure transversely oriented liner edges facing the air stream with metal nosing that has either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - 8. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional. When utilized, secure build-outs to duct walls with bolts, screws, rivets, or welds.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. VOC: Maximum 395 g/L.
 9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 10. Service: Indoor or outdoor.
 11. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Non-corrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Hilti Corp.
 - 3. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop or field fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.0 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round and flat-oval ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.1 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC RESTRAINT DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with ASCE/SEI 7.
 - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 DUCT CLEANING

- A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

- B. Use service openings for entry and inspection.
 - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
 - 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling to gain access during the cleaning process.
- D. Clean the following components by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
 - 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 - 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
 - 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 6. Provide drainage and cleanup for wash-down procedures.
 - 7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

- A. Supply Ducts:
 - 1. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.

- d. SMACNA Leakage Class for Round and Flat Oval: 6.
- B. Return Ducts:
 - 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- C. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- E. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
 - 2. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- F. Liner:
 - 1. Supply Air Ducts: Fibrous glass, Type I or Natural fiber, 2 inches thick.
 - 2. Return Air Ducts: Fibrous glass, Type I or Natural fiber, 2 inches thick.
- G. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

- 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- H. Branch Configuration:
 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

SECTION 23330 - AIR DUCT ACCESSORIES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Turning vanes.
 - 3. Duct-mounted access doors.
 - 4. Flexible connectors.
 - 5. Flexible ducts.
 - 6. Duct accessory hardware.
- B. Related Sections:
 - 1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings (if requested by Owner): For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings (if requested by Owner): Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports (if requested by Owner).
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS**2.0 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653.
 - 1. Galvanized Coating Designation: G60.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.1 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. Duro Dyne Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Ruskin Company.
 - 5. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 1-inch wg.
- E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Galvanized steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Rear mounted.
 - 6. Screen Material: Aluminum.
 - 7. Screen Type: Bird.
 - 8. 90-degree stops.

2.2 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nailor Industries Inc.
 - b. Pottorff; a division of PCI Industries, Inc.
 - c. Ruskin Company.
 - d. Vent Products Company, Inc.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nailor Industries Inc.
 - b. Pottorff; a division of PCI Industries, Inc.
 - c. Ruskin Company.
 - d. Vent Products Company, Inc.
 - 2. Standard leakage rating.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
 - 6. Blade Axles: Nonferrous metal.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Aluminum.
- C. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nailor Industries Inc.
 - b. Pottorff; a division of PCI Industries, Inc.

- c. Ruskin Company.
 - d. Vent Products Company, Inc.
 - 2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Angle shaped.
 - b. Galvanized-steel channels, 0.064 inch thick.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Neoprene.
 - 9. Jamb Seals: Cambered aluminum.
 - 10. Tie Bars and Brackets: Galvanized steel.
 - 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- D. Low-Leakage, Aluminum, Manual Volume Dampers:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Nailor Industries Inc.
 - b. Pottorff, a division of PCI Industries, Inc.
 - c. Ruskin Company.
 - d. Vent Products Company, Inc.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Angle-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
 - 6. Blade Axles: Nonferrous metal.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Neoprene.
 - 9. Jamb Seals: Cambered aluminum.
 - 10. Tie Bars and Brackets: Aluminum.
 - 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

- E. Jackshaft:
 - 1. Size: 1-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.3 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.4 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.5 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.6 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 175 deg F.
 - 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1-2004.
- D. Flexible Duct Connectors:
 - 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.
 - 2. Non-Clamp Connectors: Liquid adhesive plus tape.

2.7 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- K. Install flexible connectors to connect ducts to equipment.
- L. Connect flexible ducts to metal ducts with draw bands.
- M. Install duct test holes where required for testing and balancing purposes.
- N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.1 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

SECTION 23371 - DIFFUSERS, REGISTERS AND GRILLES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Perforated diffusers.
 - 3. Louver face diffusers.
 - 4. Adjustable bar registers and grilles.
- B. Related Sections:
 - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Verification (if requested by Owner): For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- C. Coordination Drawings (if requested by Owner): Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- D. Source quality-control reports (if requested by Owner).

PART 2 - PRODUCTS**2.0 CEILING DIFFUSERS**

- A. Rectangular and Square Ceiling Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Size: 24 by 24 inches.
 - 5. Face Style: Three cone.
 - 6. Mounting: T-bar.
 - 7. Pattern: Fixed.

8. Dampers: Combination damper and grid.
9. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.
- B. Perforated Diffuser:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 2. Material: Steel backpan and pattern controllers, with aluminum face.
 3. Finish: Baked enamel, white.
 4. Face Size: 24 by 24 inches.
 5. Duct Inlet: Round.
 6. Face Style: Flush.
 7. Mounting: T-bar.
 8. Pattern Controller: None.
 9. Dampers: Combination damper and grid.
 10. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.
- C. Louver Face Diffuser:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 2. Devices shall be specifically designed for variable-air-volume flows.
 3. Material: Aluminum.
 4. Finish: Baked enamel, white.
 5. Face Size: 24 by 24 inches.
 6. Mounting: T-bar.
 7. Pattern: One-way, Two-way, Two-way corner, Three-way, Four-way core style.
 8. Dampers: Combination damper and grid.
 9. Accessories:
 - a. Square to round neck adaptor.
 - b. Adjustable pattern vanes.
 - c. Throw reducing vanes.
 - d. Equalizing grid.
 - e. Plaster ring.
 - f. Safety chain.
 - g. Wire guard.
 - H Sectorizing baffles.
 - i. Operating rod extension.

2.1 REGISTERS AND GRILLES

- A. Adjustable Bar Register:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Price Industries.
 - b. Titus.
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
- 5. Core Construction: Removable.
- 6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
- 7. Frame: 1 inch wide.
- 8.
- 9. Mounting: Countersunk screw.
- 10. Damper Type: Adjustable opposed blade.
- 11. Accessories:
 - a. Rear-blade gang operator.
 - b. Filter.
- B. Adjustable Bar Grille:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Price Industries.
 - b. Titus.
 - 2. Material: Aluminum.
 - 3. Finish: Baked enamel, white.
 - 4. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
 - 5. Core Construction: Removable.
 - 6. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
 - 7. Frame: 1 inch wide.
 - 8. Mounting: Countersunk screw.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Owner for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

SECTION 23740 – SPLIT-SYSTEM AIR-CONDITIONERS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Electric-heating coils.
 - 3. Gas furnace.
 - 4. Integral, space temperature controls.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in condensing units. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: split-systems shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each split-system, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings (if requested by Owner): Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Wind Loading Qualification Certification (if requested by Owner): Submit certification that specified equipment will withstand wind forces identified in "Performance

Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that split-systems, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Coordination Drawings (if requested by Owner): Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which equipment will be attached.
 2. Pads and curbs used for equipment support.
- F. Field quality-control test reports (if requested by Owner).
- G. Operation and Maintenance Data: For split-systems to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 2. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of split-systems that may fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each air-handling unit.
 - 3. Gaskets: One set for each access door.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation
 - 2. Owner approved equal

2.1 UNIT CASINGS

- A. Unit casings shall be formed, galvanized steel construction with welded assembly. Galvanized steel surfaces shall be bonderized and painted with baked acrylic enamel for complete weather protection. Accessories and components shall match and interlock with all other split system components. Fan coil unit casings shall be fully internally insulated with liner which meets NFPA 25/50 flame spread/smoke developed ratings.

2.2 INDOOR UNITS

- A. Concealed Evaporator-Fan Components:
 - 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 2. Insulation: Faced, glass-fiber duct liner.
 - 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 - 4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 - 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 - 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23051 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 - 7. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil

headers, and return bends) and humidifiers, and to direct water toward drain connection.

- 1) Depth: A minimum of 2 inches deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1 (DN 25).
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- B. Floor-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
 - a. Discharge Grille: Steel with surface-mounted frame.
 - b. Insulation: Faced, glass-fiber duct liner.
 - c. Drain Pans: Galvanized steel, with connection for drain; insulated.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 4. Fan: Direct drive, centrifugal.
 5. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23051 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

2.3 OUTDOOR UNITS

- A. Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Refrigerant: R-410A.
 - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 4. Fan: Aluminum-propeller type, directly connected to motor.
 5. Motor: Permanently lubricated, with integral thermal-overload protection.
 6. Low Ambient Kit: Permits operation down to 45°F (7°C).
 7. Mounting Base: Polyethylene.

2.4 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in

- the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
 - C. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.
 - D. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and furnace-mounted frame are anchored to building structure.
 - E. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 ACCESSORIES

- A. Automatic-reset timer to prevent rapid cycling of compressor.
- B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- C. Drain Hose: For condensate.

2.6 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: MERV 8.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Propane gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- E. Safety Controls:
 - 1. Gas Control Valve: Two stage.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in over-current protection.

2.9 CONTROLS

- A. Comply/Coordinate with automatic temperature controls, thermostat, and sequence of operation this section. Refer to mechanical drawings for additional information.

- B. Automatic Temperature Controls:
1. Contractor shall furnish and install all HVAC control boards, sensors, low voltage controls wiring and make termination connections for same. Conductor raceway to be provided by electrical contractor if required for controls wiring. Coordinate installation with electrical contractor.
 2. The contractor shall, after the installation is complete, check and adjust all controls and verify that they are operating properly. The controls shall be warranted against defects in workmanships and material for a period of one (1) year after acceptance by the owner. The contractor shall instruct the owner or the designated representative, in the operation of the temperature controls.
- C. Basic Unit Controls:
1. Control-voltage transformer.
 2. Wall-mounted programmable thermostat with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Manual changeover.
 - e. Adjustable dead-band.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - i. Unoccupied-period-override push button.
 - j. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.
- D. Sequence of Operations: Split DX, Heat Pump, Gas Furnace with Cooling Air Handling Unit (AHU).
1. Contractor shall furnish and/or install all necessary control devices to accomplish the following sequence of operation:
 - a. During occupied hours the supply fans shall operate continuously, and the outside air damper shall open to the minimum scheduled position (adjustable). When the outdoor temperature is above 55°F (adjustable), and the space temperature is 1°F above cooling setpoint, cooling shall be energized in stages (where applicable) until 1°F below setpoint is achieved. When the outdoor temperature is below 55°F (adjustable), and space temperature is above cooling setpoint, cooling shall deenergize, and outside air dampers and return air dampers shall modulate to provide a supply air temperature to satisfy the demand for cooling. If the space temperature falls 1°F below the heating setpoint, and the outdoor damper is at the minimum position, electric heat shall be energized in stages (where applicable) until 1°F above setpoint is achieved.
 - b. During unoccupied hours, the supply fans shall deenergize and the outdoor damper shall close. If the space temperature rises 1°F above the cooling setpoint, the fans shall energize. cooling shall be energized in stages (where applicable). When the space temperature falls below cooling setpoint, cooling and fans shall deenergize. If the space temperature falls below the heating setpoint, the fans shall energize. electric/gas heat shall be energized in stages (where applicable). When the space temperature rises above the heating setpoint, electric/gas heat and fans shall be deenergized.
 - c. A provided or field installed pan overflow switch will disable all fans, cooling, heating, and close outdoor air damper if high water is sensed in the pan.
 - d. Setpoints (adjustable):
 1. Occupied:
 - a. Heating: 70°F

- b. Cooling: 74°F
- 2. Unoccupied:
 - a. Heating: 60°F
 - b. Cooling: 85°F

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of split-systems.
- B. Examine roughing-in for split-systems to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where split systems will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on approved equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base (minimum 4"). Polyethylene mounting base is acceptable where approved by AHJ. Roof-mounted compressor-condenser components shall be installed on approved roof stands or curbs. Refer to mechanical drawings for additional information.
 - 2. AHU/gas furnace shall be mounted on raised pad, approved stand, or ceiling hung and shall be installed to fit into the space available and meet minimum clearances from combustible surfaces or for the servicing of the equipment as required by the manufacturer and regulatory requirements. Refer to mechanical drawings for additional information.
 - 3. Install wind and seismic restraints where required according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap.
- B. Install piping adjacent to split-systems to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Connect supply ducts to AHU/gas furnace with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection forms.

3.4 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Clean flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Remove packing from vibration isolators.
 - 13. Inspect operation of barometric relief dampers.
 - 14. Verify lubrication on fan and motor bearings.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 19. Operate unit for an initial period as recommended or required by manufacturer.
 - 20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record the flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 21. Calibrate thermostats.
 - 22. Adjust and inspect high-temperature limits.
 - 23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.

24. Start refrigeration system and measure and record the following when ambient is a minimum of 15°F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.
29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.5 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing split-system and air-distribution systems, clean filter housings and install new filters.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain split-systems. Refer to Division 01 Section "Demonstration and Training."

SECTION 23741 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Hot-gas reheat.
 - 3. Electric-heating coils.
 - 4. Gas furnace.
 - 5. Economizer outdoor- and return-air damper section.
 - 6. Integral, space temperature controls.
 - 7. Roof curbs.

1.2 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- H. VVT: Variable-air volume and temperature.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

- B. Shop Drawings (if requested by Owner): Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Wind Loading Qualification Certification (if requested by Owner): Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that RTUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Coordination Drawings (if requested by Owner): Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which RTUs will be attached.
 - 2. Roof openings
 - 3. Roof curbs and flashing.
- F. Field quality-control test reports (if requested by Owner).
- G. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with ARI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 2. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that may fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
 - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set for each belt-driven fan.
 - 2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation
 - 2. Owner approved equal

2.1 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1. Exterior Casing Thickness: 0.052 inch thick.
- C. Inner Casing Fabrication Requirements:
 - 1. Inside Casing: Galvanized steel, 0.028 inch thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Thickness: 1/2 inch.
 - 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.

- 3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.2 FANS

- A. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- C. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.
- D. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fan-mounted frame and RTU-mounted frame are anchored to building structure.
- E. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Copper-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Coil Split: Interlaced.
 - 4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections complying with ASHRAE 62.1.
- B. Outdoor-Air Refrigerant Coil:
 - 1. Copper plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
- C. Hot-Gas Reheat Refrigerant Coil:
 - 1. Copper-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
- D. Electric-Resistance Heating:
 - 1. Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
 - 2. Over-temperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.
 - 3. Over-current Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
 - 4. Control Panel: Unit mounted with disconnecting means and over-current protection. Include the following controls:
 - a. Mercury contactors.
 - b. Step Controller: Pilot lights and override toggle switch for each step.
 - c. SCR Controller: Pilot lights operate on load ratio, a minimum of five steps.
 - d. Time-delay relay.

- e. Airflow proving switch.

2.4 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal over-current and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant filter/dryer.
 - 3. Manual-reset high-pressure safety switch.
 - 4. Automatic-reset low-pressure safety switch.
 - 5. Minimum off-time relay.
 - 6. Automatic-reset compressor motor thermal overload.
 - 7. Brass service valves installed in compressor suction and liquid lines.
 - 8. Low-ambient kit high-pressure sensor.
 - 9. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
 - 10. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.5 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: MERV 8.

2.6 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Propane gas.
- 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- 3. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- E. Safety Controls:
 - 1. Gas Control Valve: Two stage.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.7 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
 - 1. Damper Motor: Modulating with adjustable minimum position.
 - 2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in over-current protection.

2.9 CONTROLS

- A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
- B. Basic Unit Controls:
 - 1. Control-voltage transformer.
 - 2. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Manual changeover.
 - e. Adjustable dead-band.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 - i. Unoccupied-period-override push button.
 - j. Data entry and access port to input temperature and humidity set points, occupied and unoccupied periods, and output room temperature and humidity, supply-air temperature, operating mode, and status.
 - 3. Wall-mounted humidistat or sensor with the following features:
 - a. Concealed set point.
 - b. Concealed indication.
 - 4. Remote Wall-Mounted Annunciator Panel for Each Unit:
 - a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
 - b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
 - c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.
- C. DDC Controller:
 - 1. Controller shall have volatile-memory backup.
 - 2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
 - b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
 - c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 Section "Fire Detection and Alarm."
 - d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
 - e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.
 - 3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of four programmable periods per day.
 - 4. Unoccupied Period:
 - a. Heating Setback: 55 deg F.
 - b. Cooling Setback: System off.
 - c. Override Operation: Two hours.

5. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
6. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
 - c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.
7. Hot-Gas Reheat-Coil Operation:
 - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
 - b. Unoccupied Periods: Reheat not required.
8. Gas Furnace Operation:
 - a. Occupied Periods: Stage burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
9. Electric-Heating-Coil Operation:
 - a. Occupied Periods: Stage coil to maintain room temperature.
 - b. Unoccupied Periods: Energize coil to maintain setback temperature.
10. Economizer Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to for minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

2.10 ROOF CURBS

- A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1-1/2 inches.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- C. Curb Height: 14 inches.
- D. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for wind-load requirements.

PART 3 - EXECUTION**3.0 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
- B. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap.
- B. Install piping adjacent to RTUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
 - 4. Install return-air duct continuously through roof structure.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, coils, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean condenser coil and inspect for construction debris.
 - 10. Clean flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Remove packing from vibration isolators.
 - 13. Inspect operation of barometric relief dampers.
 - 14. Verify lubrication on fan and motor bearings.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
 - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 19. Operate unit for an initial period as recommended or required by manufacturer.
 - 20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record the flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 21. Calibrate thermostats.
 - 22. Adjust and inspect high-temperature limits.
 - 23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
 - 24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
 - 25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
 - 26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
 - 27. Simulate maximum cooling demand and inspect the following:

- a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
- 28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.
- 29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.5 CLEANING AND ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01 Section "Demonstration and Training."

SECTION 23750 – INFRARED RADIANT TUBE HEATERS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes indoor infrared radiant tube heaters.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): Include manufacturer's technical data for each specified unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings (if requested by Owner). Furnish 4 copies of the engineering specification form, showing physical dimensions, installation detail, recommendations, control wiring diagrams, and spare parts list.
- C. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that radiant heaters, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Coordination Drawings (if requested by Owner): Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which Heaters will be attached.
- E. Field quality-control test reports (if requested by Owner).
- F. An Installation, Operation, and Maintenance Manual shall be supplied with each heater.
- G. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Radiant tube heaters shall be furnished and installed in accordance with governing codes and as shown per drawing(s) provided.
- B. Radiant tube heaters shall be Design Certified by CSA and comply with current Occupational Safety and Health Act (OSHA) Requirements. The supplier shall provide the CSA Certification Number and the heaters shall bear the CSA Seal of Certification. The heaters low fire and high fire modes of operation must be Design Certified by CSA.
- C. Installation of equipment must be performed by a contractor qualified in the installation and service of equipment supplied by the manufacturer and conform to all requirements set forth in the manufacturer's manuals and all applicable governmental authorities.

1.4 WARRANTY

- A. Special Warranty: The manufacturer shall provide a written limited warranty covering the heavy one-piece cast iron burner for a period of ten (10) years, the emitter tube for a

period of five (5) years and all components utilized in the heater's control assembly for a period of one (1) year.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Space Ray
 - 2. Robert Gordon Products: Vantage II CTH3-Lit

2.1 PRODUCT REQUIREMENTS

- A. The heater's burner shall consist of a heavy-duty cast iron atmospheric burner. The flame characteristics shall be highly luminous for maximum radiant heat transfer through the emitter tube wall.
- B. The heater's emitter tube shall operate at an average surface temperature of 700°F - 800°F and shall be made of 16-gauge calorized aluminized steel or calorized titanium alloy Alumi-Therm steel (4" O.D.). The emitter tube shall be calorized for longevity, corrosion resistance, and high radiant efficiency. The measured surface emissivity shall be 0.83 - 0.86 at operating temperature. The calorization process shall produce an emitter tube that is highly radiant absorptive (0.95) on the interior and highly radiant emissive (0.83-0.86) on the exterior. The system shall have a radiant efficiency (or radiant coefficient) of 58%.
- C. The heaters shall operate under negative pressure at all times during operation to preclude the escape of combustion gases inside the building. The heater exhaust assembly shall include a 120-volt draft inducer. The draft inducer shall be equipped with a permanently lubricated, totally enclosed and shielded, fan cooled, and heavy-duty ball bearing motor. The motor shall not require maintenance or lubrication for the life of the unit. The draft inducer assembly shall be capable of rotating 90° for vertical or horizontal venting.
- D. The heaters will be CSA design certified for vertical or horizontal venting, maximum 75 feet horizontal sidewall venting, and for 50 feet outside combustion air inlet duct. There shall be no draft hoods. The combustion chamber shall be totally enclosed.
- E. The heaters shall utilize factory assembled, highly efficient aluminum reflectors with a reflectivity of 97.5%. The reflector ends shall be enclosed for maximum radiant heat output and minimum convection losses.
- F. The heaters shall be factory assembled and tested.
- G. Heaters shall operate satisfactorily in any position from horizontal to forty-five degrees (45°) from horizontal, and incline mounted up to 2/12 pitch, and shall be suitable for vented/indirect vented applications.
- H. Heaters shall be design certified by the American National Standard Z83.20/CSA 2.34.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of radiant heaters.
- B. Examine roughing-in for radiant heaters to verify actual locations of piping and duct connections before equipment installation.
- C. Examine walls/roofs for suitable conditions where radiant heater vents may be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 GENERAL INSTALLATION

- A. Installation of radiant heaters shall be in accordance with all applicable codes shown in the instructions and/or the local codes and authorities having jurisdiction.
 - 1. If necessary contact the local Building Inspector and/or Fire Marshal for guidance.
- B. Heaters shall be installed by a licensed contractor or licensed installer. Maintain minimum clearances to combustibles as outlined in manufacturer's installation manual. In areas used for storage of combustible materials stacked below the heater, NFPA54 requires that the installer post signs that specify the maximum permissible stacking height to maintain the required clearances from the heater to combustibles.
 - 1. Ensure there is adequate air circulation around the heater and that supply air for combustion, ventilation and distribution is in accordance with all regulatory requirements.
 - 2. If a heater will be installed in a high altitude area (above 2,000'), arrange for the manufacturer to design and fabricate the unit to meet the altitude requirements.
 - 3. Every heater shall be located with respect to building construction and other equipment so as to permit access to the heater.
 - 4. The installer shall consider combustible materials, vehicles parked below, lights, overhead doors, storage areas with stacked materials, sprinkler heads, gas and electrical lines and any other possible obstructions or hazards prior to placement of the unit. Consideration also must be given to service accessibility.
 - a. Plan location of fasteners and supports and ensure that manufacturer's support load requirements are met.
- C. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 VENTING

- A. The venting must be installed in accordance with manufacturer's requirements and the following codes:
 - 1. Latest edition of the National Fuel Gas Code (ANSI Z223.1–latest edition) or the authority having jurisdiction.
- B. Un-insulated single-wall metal pipe shall not be used.
- C. In regions of the country where prevailing winds are consistently higher than 40 mph, it may be necessary to terminate the vent system above the roof level. Other venting references can be found in equipment volume of the ASHRAE Handbook.
 - 1. When venting the heater to outside of building through a roof, use 4 inch I.D. double walled insulated metal pipe. This is to be constructed of galvanized sheet metal or other approved noncombustible corrosion-resistant material as allowed by state or local codes.
 - 2. A vent passing through a combustible roof shall extend through a 2-inch clearance roof thimble.
- D. A manufacturer approved vent cap must be attached to end of the flue.
- E. The size and length of vent pipe should be meet manufacturer and regulatory requirements.
- F. Avoid locating elbows in the first 5 ft. of vent pipe whenever possible. Limit the quantity of 90° elbows to two (2).
- G. Horizontal vent piping must have 1/4 inch per foot rise.
- H. Joints between sections of piping shall be fastened by sheet metal screws or other approved means and should be sealed to prevent leakage of flue gas into building. Refer to Division 23 Metal Ducts.
- I. All portions of the vent pipe shall be supported to prevent from sagging. Refer to Division 23 Hangers and Supports for HVAC Piping and Equipment.

- J. When the vent pipe passes through areas where the ambient temperature is likely to induce condensation of the flue gases, the vent pipe should be insulated and a condensation drain should be provided.
- K. Venting system shall terminate at least 3 ft. (0.9m) above any forced air inlet located within 10 ft. (3.1m).
- L. For pitched roofs, the vent shall terminate above the roof line so that no discharge opening is less than 2 feet (0.6m) horizontally from the roof surface. Consult manufacturer and regulatory requirements.
- M. When venting the heater horizontally through a combustible outside sidewall, the same requirements listed previously for venting vertical through the roof apply except as follows:
 - 1. The horizontal venting system shall not terminate:
 - a. Less than 4 ft. (1.2m) below, 4 ft. (1.2m) horizontally from, or 1 ft. (30cm) above any door, window or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 7 ft. (2.1m) above grade or above snow accumulation level as determined by local codes.
 - b. Less than 3 ft. (0.9m) from a combustion air inlet.
 - c. Less than 3 ft. (0.9m) from any other building opening or any gas service regulator.
 - d. Directly over areas where condensate or vapor could create a nuisance or hazard or be harmful to the operation of gas utility meters, regulators, relief valves, or other equipment. Building materials should be protected from flue gases and condensate.
- N. Common venting of multiple heaters in confined spaces is prohibited.
- O. Follow manufacturer and regulatory requirements for provision of combustible and outside make-up air.

3.3 CONNECTIONS

- A. The heater must be electrically grounded in accordance with the following codes:
 - 1. National Electrical Code®,
 - 2. NFPA 70 - latest revision. Wiring must conform
 - 3. CSA C22.1 Part 1 - latest revision.
 - 4. Locality where the installation is made.
- B. The wiring providing power to the heater shall be connected to a designated breaker.
- C. A fused disconnect may be required by local codes and shall be located in the vicinity of the heater (check local codes for allowable distances) and should be identified as Heater Service Switch.
- D. All electrical wiring must be located in accordance with the required clearances to combustibles below the heater as listed on the nameplate on the heater.
- E. When connecting the supply circuit to the heater, wiring material having a minimum size of 14 AWG and a temperature rating of at least 90°C shall be used.
- G. Connect gas supply in accordance with the latest edition of National Fuel Gas Code (ANSI Z223.1) and local building codes.
- F. All gas supply lines must be located in accordance with the required clearances to combustibles.
- G. Pipe joint compounds must be resistant to the action of liquefied petroleum gases.
- H. Where local codes do not prohibit, install a CSA or U.L. approved flexible connector (minimum 5/8" I.D.) between the rigid piping and the heater. A union and an approved shut off valve shall be installed before the control valve inlet. The shut off valve shall be installed within 6 feet of the union.
- I. After all gas connections have been made, make sure the heater and all gas outlets are turned off before the main gas supply is turned on. Turn the gas pressure on and check for leaks utilizing a soap suds solution and apply at all connections and joints.

3.4 TESTING AND ADJUSTMENT

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit housing.
 - 2. Inspect for visible damage to burner.
 - 3. Inspect internal components.
 - 4. Verify that labels are clearly visible.
 - 5. Verify that clearances have been provided for servicing.
 - 6. Verify that controls are connected and operable.
 - 7. Inspect flue and clean of any construction debris.
 - 8. Connect and purge gas line.
 - 9. Inspect operation of ventilation.
 - 10. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 11. Operate unit for an initial period as recommended or required by manufacturer.
 - 12. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure to ensure supply meets design requirements.
 - b. Inspect operation of power vents if applicable.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at discharge.
 - e. Perform flue-gas analysis. Measure and record the flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 13. Calibrate thermostat/s.
 - 14. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

SECTION 23770 – HVAC POWER VENTILATORS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.
- B. Related Sections from Division 23 include:
 - 1. Section 23050 Common Work Results for HVAC
 - 2. Section 23051 Common Motor Requirements for HVAC
 - 3. Section 23054 Hangers and Supports for HVAC Piping and Equipment
 - 4. Section 23055 Vibration and Seismic Controls for HVAC Piping and Equipment
 - 4. Section 23311 Metal Ducts
 - 5. Section 23330 Air Duct Accessories
 - 6. Section 23371 Diffusers, Registers and Grilles

1.1 SUBMITTALS

- A. Product Data (if requested by Owner): Include manufacturer's technical data for each specified unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings (if requested by Owner). Furnish 4 copies of the engineering specification form, showing physical dimensions, installation detail, recommendations, control wiring diagrams, and spare parts list.
- C. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that waste oil furnace, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Coordination Drawings (if requested by Owner): Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Structural members to which Heaters will be attached.
- E. Field quality-control test reports (if requested by Owner).
- F. Installation, Operation, and Maintenance Manual shall be provided.

1.2 SUMMARY

- A. Section includes:
 - 1. Centrifugal roof ventilators.
 - 2. Ceiling-mounted ventilators.
 - 3. In-line centrifugal fans.
- B. Exhaust Fans shall be specifically designed to discharge contaminated air up and away from building surfaces.

1.3 QUALITY ASSURANCE

- A. Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by

Underwriters Laboratories (UL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

- B. The installation shall fully comply with the following NFPA Codes: 30 – Flammable and Combustible Liquids, 30A – Motor Fuel Dispensing Facilities and Repair Garages, 31 – Standard for the Installation of Oil-Burning Equipment, 70 – National Electrical Code, 88A Standard for Parking Structures, 88B – Standard for Repair Garages, and 211 – Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances as applicable.
- C. The installation shall fully comply with the following International Codes: International Building Code, International Mechanical Code, International Fire Code, and the International Fuel Gas Code as applicable.

1.5 RECEIPT AND HANDLING

- A. Receiving and Inspection: Immediately upon receipt of the fan, carefully inspect the fan and accessories for damage and shortage.
 - 1. Turn the wheel by hand to ensure it turns freely and does not bind.
 - 2. Check dampers (if included) for free operation of all moving parts.
 - 3. Record on the *Delivery Receipt* any visible sign of damage.
- B. Handling: Lift the fan by the shipping carton or lifting lugs provided under top cap. Never lift by the shaft, motor or housing.
- C. Storage: If the fan is stored for any length of time prior to installation, store it in its original shipping crate and protect it from dust, debris and the weather.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products per construction documents. Refer to mechanical plans.

2.1 FABRICATION

- A. General:
 - 1. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners.
 - 2. Structural components shall be constructed of minimum 16 gauge marine alloy spun aluminum, bolted to a rigid aluminum support structure.
 - 3. The base shall be a one piece aluminum inlet with continuously welded curb cap corners for maximum leak protection.
 - 4. Roll beaded wind band.
 - 5. Stainless steel quick release latches to provide access into the motor Compartment.
 - 6. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections.
 - 7. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust air-stream.
 - 8. Lifting lugs shall be provided to help prevent damage from improper lifting.
 - 9. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
 - 10. Unit shall be shipped in ISTA certified transit tested packaging.

- B. Wheel:
 - 1. Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub.
 - 2. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.
 - 3. Wheel shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.
- C. Motor:
 - 1. Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
- D. Bearings:
 - 1. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable, ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- E. Belts & Drives:
 - 1. Belts shall be oil and heat resistant, non-static type.
 - 2. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - 3. Drives shall be sized for 150 percent of the installed motor horsepower.
 - 4. The variable pitch motor drive must be factory set to the specified fan RPM.

PART 3 - EXECUTION

3.0 GENERAL

- A. The installation of this appliance shall be made in accordance with the manufacturers' instructions, as well as in accordance with all Federal, State, Regional, or Local Laws and / or Regulations acceptable to the Authority Having Jurisdiction (AHJ) and shall be accomplished only by a qualified, certified, and competent HVAC technician experienced in making such installations as per NFPA 31, Chapter 4, Sections 4.3.2 and 4.3.3 and the Codes and Regulations.
- B. Installation, operating, and maintenance permits may be required by the Authority Having Jurisdiction (AHJ). It is the responsibility of the General Contractor or installer of the appliance to check with the AHJ as to the proper procedures to follow for the completion of this installation.
- C. Installation inspections of the finished job may also be required by the Authority Having Jurisdiction (AHJ). It is the responsibility of the General Contractor or installer of the appliance to check with the AHJ as to the proper procedures to follow for the completion of this installation.
- D. On-site certification of the appliance may be required by the Authority Having Jurisdiction (AHJ). It is the responsibility of the General Contractor or installer of the appliance to check with the AHJ as to the proper procedures to follow for the completion of this installation.
- E. All materials utilized in the installation shall be in strict accordance with all regulatory requirements.

3.1 INSTALLATION

- A. The appliance shall be either roof mounted or suspended from structure as indicated on the drawings or directed by Owner.
- B. Termination of exhaust duct may not exceed 18" above finish floor.
- C. Reference the following sections in Division 23 of the specifications:
 - 1. Section 23050 Common Work Results for HVAC
 - 2. Section 23051 Common Motor Requirements for HVAC
 - 3. Section 23054 Hangers and Supports for HVAC Piping and Equipment

4. Section 23055 Vibration and Seismic Controls for HVAC Piping and Equipment
5. Section 23311 Metal Ducts
6. Section 23330 Air Duct Accessories
7. Section 23371 Diffusers, Registers and Grilles
- D. All louvers and grilles shall be fixed in the open position, or be interlocked with the appliance(s) so that they will open automatically during the operation of the appliance(s). The interlock must be placed on the driven member to meet manufacturer's performance requirements.
- E. The fan unit must be wired with the pit lighting so that operation is integral with lighting.
- F. Pre-Start Checks:
 - a. Lock out all the primary and secondary power sources.
 - b. Inspect and tighten fasteners and setscrews, particularly fan mounting and bearing fasteners Refer to
 - c. Inspect belt tension and pulley alignment.
 - d. Inspect motor wiring.
 - e. Ensure belt touches only the pulleys.
 - f. Rotate the wheel to ensure it rotates freely.
 - g. Ensure fan and ductwork are clean and free of debris.
 - h. Close and secure all access doors.
 - i. Restore power to fan.
- G. Start-up:
 1. Turn on the fan.
 2. Check to ensure direction of fan rotation is correct.
 3. Check for excessive vibration and correct as necessary.
 4. Check for any unusual noise and adjust.
 5. Check to be sure bearings are operating smoothly
 6. Check for proper belt alignment and tension
 7. Check for proper motor amperage and voltage

3.2 TESTING AND ADJUSTMENT

- A. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 1. Inspect for visible damage to unit housing.
 2. Inspect for visible damage of fan blade.
 3. Inspect internal components.
 4. Verify that warning and instructional labels are clearly visible.
 5. Verify that clearances have been provided for servicing.
 6. Verify that controls are connected and operable.
 7. Inspect duct and clean of any construction debris.
 8. Ensure that fan operates with pit lighting.
 9. Inspect operation of ventilation and ensure that it meets the designed air exchange.
 10. Inspect and record performance of interlocks and protective devices; verify sequences.
 11. Operate unit for an initial period as recommended or required by manufacturer.
 12. Test and adjust belt as needed for designed performance.
- B. Inspection:
 1. Inspection of the fan should be conducted at the first 30 minute, 8 hour and 24 hour intervals of satisfactory operation.
 2. During the inspections, stop the fan and inspect in accordance with manufacturer's instructions and as described in A. above.

SECTION 26050 – BASIC ELECTRICAL REQUIREMENTS**PART - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 DRAWINGS AND SPECIFICATIONS

- A. All drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.
- B. Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduits and wiring is not assured. Exact requirements shall be governed by architectural, structural and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.
- C. Should there be any discrepancies or a question of intent, refer the matter to the Owner for a decision before ordering any equipment, materials or before starting any related work.

1.2 DEFINITIONS

- A. Above Grade: Not buried in ground or embedded in concrete slab on grade.
- B. Below Grade: Buried in ground or embedded in concrete slab.
- C. Concealed: Inside building above grade and located within walls, furred spaces, crawl spaces, attics, above suspended ceilings, etc. This refers to any item not visible or directly accessible.
- D. Connect: Complete hookup of item with required services, including conduit, wires and other accessories.
- E. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general any item that is directly accessible without removing panels, walls, ceilings, or other parts of structure.
- F. Furnish: Supply and deliver complete.
- G. Install: Place, secure and connect as required to make fully operational (Perform work).
- H. Provide: See furnish above.
- I. Underground: Buried in ground, including under building slabs
- J. Use (verb): Furnish and install as defined above.
- K. Wiring: Electrical raceway, conductors and connection.

1.3 QUALITY ASSURANCE

- A. Carefully examine the contract documents, visit the site, and thoroughly become familiar with the local conditions relating to the work. Failure to do so will not relieve the contractor of the obligations of the Contract.
- B. After all equipment, devices and raceways are installed and wires and cables are in place and connected to devices and equipment, test the system for continuity, proper phase rotation, short circuit, improper grounds, polarity and other defects. If defective condition is present, make all necessary corrections and retest for compliance. Test systems for proper operation and demonstrate the operation of the system to the Owner's Representative

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

1.5 WORKMANSHIP AND INSTALLER'S QUALIFICATIONS

- A. Electrical installation shall be completed by licensed electricians, from an electrical contracting firm with at least five years of successful electrical installation experience on projects utilizing electrical components similar to those in both size and type, to those required for this project. All specialties, including computer isolated ground/ dedicated circuit power, and low voltage wiring installations shall be performed by an electrician qualified in the maintenance and installation of such systems.

1.6 SCOPE OF WORK

- A. Furnish, erect, install, connect, clean, adjust, test, condition and place into service all material and equipment in accordance with the manufacturer's directions and recommendations except as otherwise noted and provide all labor required to complete

the work shown on the drawings and/or specified in all Sections of Division 26 and all other work and miscellaneous items, not specifically mentioned, for a complete installation including all accessories required for testing the system. Such that the system is complete, code compliant and ready for operation.

- B. Apparatus, appliance, material or work not shown on drawings, but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and ready for operation, even though not specified or shown on the drawings, shall be furnished and installed without additional expense to the Owner.
- C. Delivery and Storage: Receive, handle, and store electrical items and materials at the project site. Materials and electrical items shall be so placed that they are protected from damage, weather, environmental factors and deterioration.
- D. Secure and pay for all permits, governmental fees, taxes and licenses necessary for the proper execution and completion of Division 26 work.
- E. Submit to governmental agencies and utility companies shop drawings, cutsheets, calculations, or installation drawings for the emergency lighting and exit sign system, life safety/fire alarm system, or any other system or installation element that are required by these agencies, for their approval.
- F. Maintenance Manuals: Submit two copies of maintenance manuals in hard bound covers containing shop drawings and manufacturers' repair manuals, guarantees, operating instructions, wiring diagrams and parts lists to Owner.
- G. Instruction Manuals: Submit two complete instruction manuals for any specialty system installed to Owner.
- H. Field Record Drawings: Submit field record drawings for the work in accordance with the General Conditions to Owner.

1.7 CODE COMPLIANCE

- A. Comply with NFPA 70.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. All OSHA and safety code requirements.
- D. Materials and installation shall comply with codes, laws and ordinances of Federal, State, local governing bodies having jurisdiction.
- E. In every installation where regulations of electric utility and telephone companies apply, conformance with their regulations is mandatory and any costs involved shall be included in the Contract.
- F. In case of differences between building codes, State and Federal laws, local ordinances and utility company regulations and the Contract Documents, the most stringent shall govern.

- G. In case of differences between means, materials, or methods indicated in these specifications and those indicated in the construction documents, the more stringent shall govern.
- H. Should work be performed which does not comply with the requirements of the applicable building codes, State and Federal laws, local ordinances, industry standards and utility company regulations, changes for compliance shall be done at no additional cost to the Owner.
- I. Notify the Owner of any materials or apparatus believed to be inadequate, unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction.

1.8 WARRANTY

- A. General Warranty: This special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents."

PART 2- PRODUCTS

2.0 MATERIALS AND EQUIPMENT

- A. Materials, equipment and accessories shall be new, UL listed and labeled as defined in NFPA 70 article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use, and shall bear the manufacturer's name, model number and other identification marking.
- B. Materials and equipment shall be the standard product of a manufacturer regularly engaged in the production of the required type of material or equipment for at least five years (unless specifically exempted by the Owner) and shall be the manufacturer's latest design with published properties.
- C. Equipment and materials of the same general type shall be of the same manufacture throughout the project to provide uniform appearance, operation and maintenance.
- D. Equipment and materials shall be without blemish or defect and shall not be used for temporary light or power purposes, including lamps, without the Owner Representative's written authorization.

2.1 ALTERNATE PRODUCTS

- A. Alternate Materials, fixtures, apparatus or equipment installed without written approval shall be removed by the Contractor and replaced with specified equipment at the direction of the Owner Representative and without recourse for additional compensation.
- B. Acceptance of alternates shall include provisions necessary to alter, adjust or otherwise modify work affected by the alteration.

- C. Field record drawings shall include alternate work and shall reflect changes necessitated to other work.

PART 3- EXECUTION

3.0 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. All listed materials and equipment shall be installed in accordance with their listing.
- B. The drawings for work under Division 26 are diagrammatic and are intended to convey the scope of work and indicate the general arrangement of conduit, boxes, equipment, fixtures and other work included in the Contract.
- C. Location of items required by the drawings or specifications not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site and shall be subject to the approval of the Owner's Representative.
- D. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed, and maintain maximum headroom and space conditions at all points:
 - 1. Where headroom or space conditions appear inadequate, the Owner's Representative shall be notified before proceeding with installation.
 - 2. Minor conduit rerouting and changes shall be made at no additional cost to the Owner.
 - 3. Coordinate the mounting heights of electrical equipment and raceways to clear the opening heights of doors, the heights of vehicles (cars, trucks) and the heights of equipment which needs to be removed and replaced.
- E. Perform all work with skilled mechanics of the particular trade involved in a neat and workmanlike manner.
- F. Perform all work in cooperation with other trades and the construction schedule.
- G. Furnish other trades advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit trades affected to install their work properly and without delay.
- H. Where there is evidence that work of one trade will interfere with the work of other trades, all trades shall assist in working out space allocations to make satisfactory adjustments.
- I. With the approval of the Owner's Representative and without additional cost to the Owner, make minor modifications in the work as required by structural interferences, by interferences with work of other trades or for proper execution of the work.
- J. Work installed before coordinating with other trades so as to cause interference with the work of such other trades shall be changed to correct such condition without additional cost to the Owner and as directed by the Owner's Representative.
- K. Minor changes in the locations of outlets, fixtures and equipment shall be made prior to rough-in at the direction of the Owner's Representative and at no additional cost to the Owner.

- L. Electrical Contractor shall cooperate with other trades and coordinate work so that conflicts with other work are eliminated.
- M. Equipment shall be installed with adequate space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring shall be provided without moving other equipment that is to be installed or which is in place. Electrical Contractor shall verify measurements. Discrepancies shall be brought to the Owner's Representative's attention for interpretation.
- N. Determine temporary openings in the buildings that will be required for the admission of apparatus furnished under this Division, and notify the Owner's Representative accordingly. In the event of failure to give sufficient notice in time to arrange for these openings during construction, assume all costs of providing such openings thereafter.
- O. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- P. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the contractor shall be responsible for all work and costs required to open and restore the concealed areas in addition to all required modifications.
- Q. Electrical Contractor shall refer to contract documents for details, reflected ceiling plans, and large scale drawings; will also verify any conflicts between various trades.
- R. Verify all dimensions by field measurements.
- S. Coordinate connection/shut-off and disconnection of electrical service with exterior underground and overhead utilities and services. Also coordinate with owner and utility. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
- T. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- U. Install access panel or doors where units are concealed behind finished surfaces.
- V. Verifications of Points of Connection:
 - 1. Before submitting his bid, Contractor shall visit site and contact city, owner and all utilities to verify location, size, depth and operating characteristics of points of connection.
 - 2. If Contractor fails to notify Owner in writing, it will be assumed that his bid includes everything required to provide proper connections to all present points of connection as they actually exist or as they will be provided by city or utilities, and will pay for all utility point of connection modifications, relocations, replacements, additional runs and extensions, without increase in contract price.
 - 3. Electrical Contractor shall furnish all labor, material and equipment to completely install all work shown on drawings and specified herein, including:
 - a. Installation of and final connections within HVAC control system supplied by others.
 - b. Connection to mechanical equipment: HVAC power conductors and proper grounding conductors for HVAC equipment.
 - c. Final connections to kitchen equipment.
 - d. Complete and operable Telephone System.

- e. Complete and operable Cable TV system as required.
- f. Complete and operable Internet system as required

3.1 COOPERATION

- A. Where jurisdictional rules require the assistance of electrical mechanics in the moving and setting of electrically powered equipment, provide such assistance.
- B. Where work covered by this section connects to equipment furnished under other sections, verify electrical work involved in the field and make proper connection to such equipment.

3.2 ALTERATIONS AND DEMOLITION

- A. Confer with the manufacturers of existing equipment that is to be revised or extended.
- B. Where existing electrical work prevents proper construction of new work as indicated, remove, reroute, relocate, or in other ways alter existing work in order to accommodate new work requirements.
- C. Remove suspended acoustical ceiling tiles necessary to facilitate the installation of the electrical work and restore the ceiling tiles after completion of the electrical work. Replace ceiling tiles damaged during the work with new tiles to match the existing in every respect.
- D. Where existing conduit, wire, supports, hangers, and other electrical work must be removed as a result of the alterations, they shall be completely removed, back to the first outlet which is left unaffected by the revision. Conduit which is buried in concrete or otherwise inaccessibly positioned may be abandoned. In such cases, wire shall be pulled out of conduit and the conduit itself plugged at each end.
- E. Existing electrical materials and equipment, including lighting fixtures, switches, receptacles, signal lights, speakers, intercom equipment, controls, conduit outlets, fittings, wire, cable, and other devices which are removed as a result of the alterations are the property of the Owner. Check with Owner to determine what is to be salvaged.
- F. Existing electrical materials and equipment with the exception of wire and cable, as generally outlined in the previous paragraph, shall be re-used as completely as is found practicable. Examine the condition of such materials and equipment and make a prior determination of whether it is suitable for re-use. Present findings periodically to the Owner's Representative who in turn will make the final decision regarding re-usability. All wire and cable shall be new.
- G. In order to coordinate the work of the mechanical and electrical trades, completely remove all existing electrical work in and above ceilings of these areas (as defined on the Drawings), after which install new work and re-install existing work to remain, as shown on the Drawings. Existing lighting fixtures, time-clocks, speakers, signals, and other equipment shall be re-used except as otherwise noted. If fixtures must be utilized in areas with new ceiling tile, make arrangements for cutting new tile to accommodate fixtures. Some exceptions may arise wherein equipment, either in altered areas or other areas, must be kept in service, requiring that feeders, signal conductors, conduits, boxes, etc. serving same also be kept in service. In such cases, those electrical feeders, signal conductors, conduits, etc. shall be re-routed and re-connected before present work is removed. If this is not possible, temporary wiring shall be provided to allow for installation

of mechanical work, after which new work shall be installed and temporary wiring removed.

- H. Various signal, communications, and other services shall remain in service to provide continuous operation for the Owner's functions. No interruption of any service will be allowed without written approval from the Owner.
- I. Remove or reroute all electrical feeders, risers, branch circuits, and other wiring as required by the alterations. Wiring extending through remodeled areas but serving loads which must remain shall be rerouted as required, and reconnected to those loads.

3.3 EXCAVATING AND BACKFILLING

- A. Excavating, bracing and shoring, testing, disposition of excess excavated material, provision of borrow, and placing of backfill shall be in accordance with Section Excavating and Backfilling.

3.4 CUTTING AND PATCHING

- A. Do drilling, cutting, fitting, and patching necessary for the installation of conduits, wireways, and other electrical equipment, and provide supports necessary for the same and for bracing and anchorage of work. No cutting of structural work or of fireproofing shall be done without the written consent of the Owner.
- B. Conduits passing through roofs or other surfaces exposed to weather shall be properly flashed as specified in roofing and waterproofing sections. This flashing work shall be part of this division of work.

3.5 CLEAN UP

- A. The Contractor shall, at all times, keep the premises free from the accumulation of waste materials or rubbish caused by his work and, at the completion of the work, shall remove his rubbish, tools, equipment and surplus materials; and shall leave his work clean and ready for use.

3.6 EQUIPMENT NOISE LIMITATION

- A. Noise levels of electrical devices and equipment shall be within acceptable limits as established by NEMA or other valid noise rating agencies. Noise levels shall be subject to the Owner's Representative, based on practical and reasonable considerations of occupancy requirements.
- B. Check and tighten the fastenings of sheet metal plates, covers, doors, trims, bus bars and all electrical connections to prevent vibration and chatter under normal conditions of use.
- C. Transformers, reactors, dimmers, lamp ballasts, and solenoids shall be designed and rated for "quiet" operation.
- D. Remove and replace any individual electrical item or device that is found to produce a sound energy output exceeding that of other identical devices installed at the project.

3.7 TRANSMISSION OF VIBRATION

- A. Electrical equipment, conduit, and fittings shall not be mounted to or supported by elements subject to vibration except by methods which will prevent transmission thereof. Where flexible lengths of conduit are utilized as a means of isolating equipment and conduit systems vibration, care shall be exercised to assure continuity of ground throughout.

3.8 MOUNTING HEIGHTS

- A. Mounting heights of electrical items shall be as listed on the drawings, unless otherwise required by local code requirements, the Americans with Disabilities Act, or by the Owner's Representative's field instructions. Dimensions are above finished floor, unless otherwise indicated.
- B. No switch, circuit breaker, fuse handle, disconnect or other similar device shall be mounted so that it is higher than 6'-7" AFF or working platform to comply with the readily accessible requirements of the code.

3.9 PROTECTION

- A. Protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps. Cover fixtures, materials, equipment and devices furnished or installed under this section or otherwise protect against damage, both before and after installation. Fixtures, materials, equipment, or devices damaged prior to final acceptance of the work shall be restored to their original condition or replaced.
- B. Equipment shall be inherently safe and moving parts shall be covered with guards.

3.10 TEMPORARY UTILITIES, LIGHTING AND HEAT

- A. Contractor's attention is directed to Division 01, which sets forth respective responsibilities of all concerned with furnishing temporary water, electricity, lighting and heat for use during construction of the Project.

3.11 EXECUTION, CORRELATION AND INTENT OF DOCUMENTS

- A. In the event that conflicts, if any, cannot be settled promptly and amicably between the affected trades, with work proceeding in a workmanlike manner, then the Owner's Representative shall decide which work is to be relocated and their judgment shall be final and binding on this Contractor.

3.12 INSTRUCTIONS AND ADJUSTMENT

- A. The primary adjustments and operational instructions of the system(s) shall be accomplished by the Contractor to the complete satisfaction of the Owner at the time of completion of the installation.

SECTION 26051 – BASIC ELECTRICAL MATERIALS AND METHODS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Anchors, sleeves, inserts, hangers and supports.
 - 3. Access Panels
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete equipment bases.
 - 7. Vibration isolation
 - 8. Electrical demolition.
 - 9. Cutting and patching for electrical construction.
 - 10. Touch-up painting.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.3 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS**2.0 ANCHORS, SLEEVES, INSERTS, HANGERS AND SUPPORTS**

- A. Anchor bolts, sleeves, inserts, hangers and supports required for the Electrical work shall be furnished and installed under Division 26.
- B. See Division 05 "Metal Fabrications" for additional requirements.
- C. Hangers and Supports:
 - 1. Provide hangers, angles, channels, and other supports required by field conditions to install items of electrical equipment. Design of supports and methods of fastening to building structure shall be acceptable to the Owner's Architect and acceptable to authorities having jurisdiction. Provide spring hangers for vertical raceway supports.
 - 2. No electrical items shall rest on, or depend for support on, suspended ceiling media (tiles, lath, plaster, splines, etc).
 - 3. In suspended ceilings, support conduits directly from structural slabs, decks (or framing members). Do not support conduits on ceiling suspension members.
 - 4. Support surface or pendant lighting fixture:
 - a. From an outlet box by means of an interposed metal strap, where weight is less than 5 lbs.
 - b. From an outlet box by means of a hickey or other direct threaded connection, where weight is from 5 to 50 lb.
 - c. Directly from structural slab, deck or framing member, where weight exceeds 50 lbs.
 - 5. In addition to the above, provide cushioned, swivel type hangers with appropriate outlet boxes for pendant fixtures in mechanical areas. Such hangers shall have a support rating at least twice that of the load supported.
 - 6. Provide weight-distribution facilities, where required so as not to exceed the load-bearing capabilities of floors or walls that bear the weight of, or support, electrical items.
 - 7. Hangers and supports shall be hot dipped galvanized, unless noted otherwise.
 - 8. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
 - 9. Trapeze type hangers may be used where several conduits are to be installed at the same elevation. The spacing of such trapeze hangers shall be in accordance with the NEC for the smallest conduit in the run.
- D. Sleeves and Openings:
 - 1. Provide sleeves and wireways where they pass through walls or floors.
 - 2. Sleeves shall be not less than 1" larger than outside dimension of raceways.
 - 3. Floor sleeves shall be galvanized steel pipe or plastic, as approved by code and stubbed 3" above floor. Unused sleeves shall be capped.
 - 4. Provide 3" high concrete curbs around openings through floors.
 - 5. Sleeves through kitchen or storage areas, and customer dining or other similar quiet area shall have the net openings packed with glass fiber insulation and both ends of sleeve caulked with waterproof mastic to prevent noise, dirt, air and water transmission. The utility companies shall pack the inside of their sleeves.
 - 6. Where conduits pass through floors or exterior walls, caulk sleeves with appropriate sealant at both ends to insure waterproofing around pipe.
 - 7. Where conduits pass through foundation walls, provide entrance seals.
 - 8. After the completed work is in place pack or fill sleeves and openings to prevent leakage of liquid and the spread of fire and smoke.
 - 9. Fire rated walls/floors shall be firestopped to match rating of original construction. Materials and methods shall comply with Underwriters Laboratories Directory "Fire Resistance - Vol. 1 and Vol. 11".
- E. Inserts:
 - 1. Inserts for suspended items in poured concrete construction shall be malleable-iron concrete inserts, adjustable type with insert nut.
 - 2. Inserts for surface mounted items shall be suitable for the composition of the slab, wall, or structure on which installation is to be made.
- F. Cable supports shall be compatible with wire and cable type and conduit size.

2.1 CABLE LUBRICANT

- A. The lubricant shall contain no waxes, greases, silicones or polyalkylene glycol oils or waxes.
- B. The lubricant shall have less than 6% solids residue after drying for 24 hours at 105°C.

2.2 CONDUCTIVE COMPOUNDS

- A. Copper base anti-corrosive conductive compound for conduit connections in earth or concrete in contact with earth.

2.3 ACCESS PANELS

- A. Panels shall be flangeless hinged type with vandal proof fasteners.

2.4 IDENTIFICATION OF ELECTRICAL ITEMS

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size:
 - 1. Type: Pre-tensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
 - 2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.
 - 3. Color: Black letters on orange background.
 - 4. Legend: Indicates voltage.
- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.
- D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend that indicates type of underground line.
- E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Use colors to suit coding scheme.
- G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Use black engraved letters on white background.
- H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Use weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. Provide 1/4-inch grommets in corners for mounting.
- J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.5 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

- A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company. Enclosure: NEMA Type 3R.
- B. Meter Sockets: Comply with requirements of electrical power utility company.
- C. Modular Meter Centers: Factory-coordinated assembly of a main meter center circuit-breaker unit with wireways, tenant meter socket modules, and tenant branch circuit breakers arranged in adjacent vertical sections, complete with interconnecting buses.
 - 1. Housing: NEMA 250, Enclosure: Indoor: Type 1, Outdoor: Type 3R.
 - 2. Tenant Branch Circuit Breakers: Series combination rated to protect circuit breakers in downstream panelboards that have 10,000-A interrupting capacity, minimum.

2.6 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Division 03 "Cast-in-Place Concrete."

2.7 VIBRATION ISOLATION

- A. Suspended vibration producing equipment shall have spring elements in the hanger rods or isolation pads under the equipment.

2.8 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Different / Additional requirements will be necessary in areas requiring seismic restraints for electrical equipment and components. See Division 26 "Vibration and Seismic Controls for Electrical Systems".

3.1 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system component.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.2 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Raceway Supports shall comply with NFPA 70, other applicable codes, and manufacturer's requirements.
- C. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- D. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

- E. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- F. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- G. Install 1/4-inch (6-mm) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- H. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- I. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- J. Simultaneously install vertical conductor supports with conductors.
- K. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- L. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- M. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- N. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete if approved by the authority having jurisdiction.
 - 6. Steel: Welded threaded studs or spring-tension clamps on steel:
 - a. Field Welding: Comply with AWS D1.1.
 - 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 8. Light Steel: Sheet-metal screws.
 - 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.3 INSTALLATION OF ACCESS PANELS

- A. Where items such as pull boxes, junction boxes, other specialties, or any piece of equipment or device requiring adjustment or service, are concealed in the construction, furnish an access panel for ceilings or walls to permit adjustment or service of concealed item. Design to be suitable for installation in the material forming the finished surface in which panel is mounted.

3.4 INSTALLATION OF EXPANSION FITTINGS

- A. At each building expansion joint and in each straight uninterrupted run of surface mounted conduit and vertical risers in excess of 100' an appropriate expansion fitting shall be provided, and the distance between fittings as installed shall not exceed 100 linear feet.

3.5 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.6 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 07 "Penetration Firestopping."

3.7 CONCRETE BASES

- A. The Contractor shall provide concrete pedestals, bases, pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc. for installation of equipment and apparatus.
- B. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated.

3.8 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove demolished material from Project site.
- E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing fireproofing has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.10 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work. Repair or replace as necessary; including the following:
 - 1. Raceways.
 - 2. Wire and Cable-600 Volt.

3. Supporting devices for electrical components.
4. Anchors, sleeves, inserts, hangers and supports.
5. Contractors
6. Lighting Contractors-Multiple Poles.
7. Metallic Conduit and Fittings.
8. Bushings.
9. Conduit Seals.
10. Expansion Fittings.
11. Cable Supports.
12. Cable Lubricant.
13. Conductive Compounds.
14. Cable and Feeder Taps and Splices.
15. Junction and Pullboxes.
16. Outlet Boxes.
17. Non-Metallic Conduit and Fittings-PVC.
18. Manholes.
19. Access Panels.
20. Time Switches and Photo Controls.
21. Wiring Devices.
22. Wiring Devices Plates.
23. Electrical Identification.
24. Electricity-Metering Components.
25. Concrete Equipment Bases.
26. Vibration Isolation.
27. Electrical Demolition.
28. Cutting and Patching for Electrical Construction.
29. Touchup Painting.

3.11 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 09 "Painting":
 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.12 CLEANING CONDUITS AND DUCTS

- A. After conduits (ducts) and accessories have been installed, and concreting operations are completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected. Where conduits (ducts) installed are connected to conduits (ducts) installed by others, the entire run to the nearest box, manhole, or other termination point shall be cleaned. Clearing and cleaning shall be done by pulling through each conduit (duct) a flexible cylindrical mandrel having an outside diameter 1/4" less than the inside diameter of the conduit (duct). Defects and stoppages occurring in portions of the conduit (duct) run shall be corrected.

3.13 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

SECTION 26052 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other sections.
- B. Applications of electrical grounding and bonding work to be furnished and installed by the contractor in this section shall include, but not be limited to the following (as a minimum):
 - 1. Underground metal water piping electrode.
 - 2. Ground rod electrode.
 - 3. Concrete encased electrodes.
 - 4. Metal building frame electrodes.
 - 5. Electrical power systems.
 - 6. Other grounding electrodes.
 - 7. Isolated grounding.
 - 8. Telephone equipment.
 - 9. CCTV equipment.
 - 10. CATV equipment.
 - 11. Security equipment.
 - 12. Gas piping bonding.
 - 13. HVAC ductwork bonding.
 - 14. Raceways.
 - 15. Service equipment.
 - 16. Enclosures.
 - 17. Equipment.
 - 18. Lighting standards.
 - 19. Landscape lighting.
 - 20. Signs.

1.2 SUBMITTALS

- A. Submit detailed drawings, calculations, and/or test results to the authorities having jurisdiction where required for approval, showing all grounding details, grounding installation and material specifications. The work shall not proceed until this approval has been obtained.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Electrical System grounding and individual equipment grounding shall in all instances conform to the minimum requirements of NFPA 70, The National Electric Code, local codes or regulations, and regulations of the serving utilities, except where McDonald's corporate standards exceed those minimum requirements.
- D. Comply with latest NFPA 70.

PART 2 - PRODUCTS**2.0 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Grounding Conductors:
 - 1. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
 - 2. Material: Copper.
 - 3. Equipment Grounding Conductors: 600 Volt Insulated copper with green-colored insulation.
 - 4. Isolated Ground Conductors: 600 Volt Insulated copper with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
 - 5. Grounding Electrode Conductors: 600 Volt stranded copper insulated conductors.
 - 6. Feeder Grounding Conductors: 600 Volt stranded copper insulated conductors, unless otherwise indicated.
 - 7. Copper Bonding Conductors: As follows:
 - a. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor, unless otherwise indicated.
 - b. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inches thick.
 - 8. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.1 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.2 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel 5/8 in diameter by 96 inches long.
- B. Concrete encased ground (Ufer).

PART 3 - EXECUTION**3.0 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods: Bolted connectors.
4. Connections to Structural Steel: Bolted or Welded connectors.

3.1 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.2 EQUIPMENT GROUNDING

- A. Comply with NFPA 70, Article 250, for types, sizes and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install insulated equipment grounding conductors with all feeders and branch circuits.
- C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Metal-clad cable runs.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- F. Technology/POS Isolated Ground/Dedicated Circuits: Install insulated equipment grounding conductor (green) and an insulated isolated grounding conductor (green with yellow strip) in a separate dedicated branch-circuit conduit run from subpanel to the junction box containing the isolated ground receptacle serving said equipment. Bond one end of the equipment grounding conductor (green) at the ground bus in source subpanel and the other to the junction box housing the isolated ground receptacle. Bond the isolated grounding conductor to the isolated ground bus in the source subpanel and the other to the isolated ground receptacle's isolated ground terminal.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

- H. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors. Metal pole, grounding electrode, and equipment grounding conductor shall be bonded together to form a common ground point at the grounding lug of metal pole.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting or water meter is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding system at service entrance.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner may engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports for the following:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner's Representative promptly and include recommendations to reduce ground resistance.

SECTION 26053 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. RMC: Rigid metal conduit.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. The following wiring methods SHALL NOT be used: Non-Metallic sheathed cable (Romex, NM, NMC and NMS), Armored Cable Type AC (BX), Electrical Non-Metallic Tubing, Type ENT (Smurf-Tube).

1.4 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system and partition assemblies.

PART 2 - PRODUCTS**2.0 GENERAL**

- A. Provide conduit and fittings of types, grades sizes and wall thickness for each service indicated. Where types and grades are not indicated, provide proper selection to fulfill wiring requirements listed within this specification and to comply with the applicable portions of the NEC and local, state and federal codes for raceways and installations.
- B. Provide complete raceway systems and enclosures for all wiring throughout the extent of the systems specified.

2.1 METAL CONDUIT AND FITTINGS

- A. RMC: Provide rigid steel, zinc coated, threaded type conforming to ANSI C80.1 and UL6.

- B. IMC: Rigid intermediate grade hot-dip galvanized, threaded type conforming to ANSI C80.6 and UL124Z.
- C. EMT and Fittings: Zinc coated steel conforming to ANSI C80.3 and UL 797.
 - 1. Fittings: Set-screw or compression type by application and requirements listed in raceway application section. Indenter type and cast fittings shall not be utilized.
- D. FMC: Formed from continuous length of spirally wound, interlocked zinc-coated steel conforming to UL1.
- E. LFMC: Constructed with single strip, flexible, continuous, interlocked and double wrapped flexible steel; galvanized inside and outside; coated with liquid tight jacket of flexible polyvinyl chloride (PVC) sunlight and UV resistant.
- F. Fittings for Conduit (Including all Types and Flexible and Liquid Tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
- G. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND FITTINGS

- A. RNC: Heavy wall conduit: NEMA TC 2, Schedule 40 and Schedule 80 PVC, 90° C UL-rated, constructed of polyvinyl chloride and suitable for direct burial use. Sunlight and UV resistant.
- B. RNC Fittings: NEMA TC 3; compatible with conduit type and suitable for use and location.

2.3 METAL WIREWAYS, FITTINGS AND ACCESSORIES

- A. Material and Construction: Sheet metal sized and shaped as indicated; Indoor: NEMA 1 Outdoor: NEMA 3R.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type or as indicated in Construction Documents.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- G. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.0 RACEWAY APPLICATION

- A. Outdoors: (for specific applications and appropriate fittings, see table 3.0 this section)
 - 1. Exposed Conduit: RMC, IMC.
 - 2. Concealed: RMC, IMC.
 - 3. Below Grade, Single Run: RNC, RMC.
 - 4. Below Grade, Grouped: RNC, RMC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 3R or 4.
- B. Indoors: (for specific applications and appropriate fittings, see table 3.0 this section)
 - 1. Exposed Conduit: RMC, IMC.
 - 2. Concealed: EMT, IMC.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - 4. Damp or Wet Locations: Rigid steel conduit. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or wet Locations: NEMA 250, Type 4, stainless steel.
- C. Table 3.0 – Application of raceways and fittings, unless otherwise specified.

LOCATION	120/240V / 208V		LOW ENERGY*
EXPOSED			
Lower Level	Per code but not less than 1/2" min. EMT w/ steel set screw couplings		EMT compr. ftgs.
Outdoors	RMC or IMC threaded ftgs.		RMC or IMC threaded ftgs.
CONCEALED			
Walls	Per code but not less than 3/4" min. EMT w/ steel set screw couplings		EMT 1/2" - 2" set screw ftgs
Air Handling Ceiling/Space	Per code but not less than 3/4" min. EMT w/ compr. Fittings		EMT compr. ftgs.
Non Air Handling Ceiling/Space	Per code but not less than 3/4" min. EMT w/ steel set screw couplings		EMT 1/2" - 2" set screw ftgs

BELOW GRADE			
Interior	IMC threaded ftgs. or Schedule 40 or 80 PVC		IMC threaded ftgs. Schedule 40 or 80 PVC
Exterior	Schedule 40 or 80 PVC or RMC threaded ftgs		Schedule 40 or 80 PVC or RMC threaded ftgs

- D. Install low energy conductors in designated conduit and fittings as required by code and authority having jurisdiction.

3.1 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- C. Do not install aluminum conduits in contact with concrete.
- D. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Complete raceway installation before starting conductor installation.
- F. Support raceways as specified in accordance with NFPA 70.
- G. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- H. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- I. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
- J. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- N. Raceways for Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Install pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- O. Flexible Conduit Connections: Use maximum of 6' whip of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Installation shall include an integral equipment grounding conductor.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.2 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 31 Section "Earth Moving."
 - 3. Backfill and compact around conduit following installation. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand-tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
 - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.3 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with fire-stop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with fire-stop materials.
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work and architectural drawings.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position the raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.7 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

SECTION 26054 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Channel support systems.
 - 3. Restraint cables.
 - 4. Hanger rod stiffeners.
 - 5. Anchorage bushings and washers.

1.2 DEFINITIONS

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 QUALITY ASSURANCE

- A. Comply with seismic restraint requirements in IBC, BOCA, California Building Code/Code of Regulations of OSHPD, SBC, and UBC, unless requirements in this Section are more stringent.
- B. If location of this electrical installation requires seismic considerations, seismic design and Shop Drawings shall be signed and sealed by a qualified professional or structural engineer.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints as required.
 - 2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner): For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
- B. Delegated-Design Submittal (if requested by Owner): For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.
 - 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 - 3. Field-fabricated supports.
 - 4. Seismic-Restraint Details:

- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
- C. Coordination Drawings (if requested by Owner): Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- D. Welding certificates (if requested by Owner).
- E. Qualification Data (if requested by Owner): For professional engineer and testing agency.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from OSHPD, pre-approval by ICC-ES, or pre-approval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.0 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- C. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- E. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- H. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with

strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

- I. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.1 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 APPLICATIONS

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.2 SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment and Hanger Restraints:
 1. Install restrained isolators on electrical equipment.
 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage as required by Authority having jurisdiction a qualified testing agency to perform tests and inspections and prepare test reports. Submit final reports to Owner.

SECTION 26055 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI Z535.4 for safety signs and labels.
- D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS**2.0 UNDERGROUND-LINE WARNING TAPE**

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.1 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.2 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with letter and face colors indicated on design documents or as required by code.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Provide white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.4 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.1 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
1. Emergency Power.
- B. Power-Circuit Conductor Identification, 600 V or Less:
1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - 5) Ground: Green.
 - 6) Isolation Ground: Green with Yellow Strip.

- c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source.
- D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
 - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- G. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer load shedding.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label, or as indicated on drawings. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.

- c. Access doors and panels for concealed electrical items.
- d. Switchgear.
- e. Emergency system boxes and enclosures.
- f. Enclosed switches.
- g. Enclosed circuit breakers.
- h. Enclosed controllers.
- i. Push-button stations.
- j. Power transfer equipment.
- k. Contactors.
- l. Remote-controlled switches, dimmer modules, and control devices.
- m. Battery-inverter units.
- n. Monitoring and control equipment.

SECTION 26092 - LIGHTING CONTROL DEVICES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Time switches.
 - 2. Outdoor or indoor photoelectric switches.
 - 3. Indoor occupancy sensors.
 - 4. Lighting contactors.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
- B. Shop Drawings (if requested by Owner): Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- C. Operation and Maintenance Data : For each type of product to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system (if applicable), and partitions.

PART 2 - PRODUCTS**2.0 TIME SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis-of-Design Product: Subject to compliance with requirements as shown on Construction Documents.
- B. Electronic Programmable Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
 - 1. Contact Configuration: Form-C contacts for normally open and closed circuits.
 - 2. Contact Rating: 20-A ballast load, 120/240-V ac.
 - 3. Programs: channels; each channel shall be individually programmable with 8 on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
 - 4. Program: Exterior lighting and signs
 - 5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 - 6. Astronomic Time: channels.
 - 7. Battery Backup: For schedules and time clock.
 - 8. Four (4) independently controlled outputs.

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with SPDT dry contacts rated for, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - 1. Light-Level Monitoring Range: 0 to 3500 fc, with an adjustment for turn-on and turn-off levels.
 - 2. Time Delay: 15-second minimum, to prevent false operation.
 - 3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - 4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR PHOTOELECTRIC SWITCHES (if applicable)

- A. Ceiling-Mounted Photoelectric Switch: Solid-state, light-level sensor unit, with separate relay unit, to detect changes in lighting levels that are perceived by the eye. Cadmium sulfide photoresistors are not acceptable.
 - 1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for, and for 1/2 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 3. Light-Level Monitoring Range: 10 to 200 fc, with an adjustment for turn-on and turn-off levels within that range.
 - 4. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.3 INDOOR OCCUPANCY SENSORS (if applicable)

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.
- C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot high ceiling in a corridor not wider than 14 feet.
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

2.4 LIGHTING CONTACTORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- B. Manufacturers: Subject to compliance with requirements, provide products as specified on drawings.
- C. Description: Electrically operated and mechanically or electrically held, as defined on Drawings, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

PART 3 - EXECUTION

3.0 SENSOR INSTALLATION (if applicable)

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.1 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 2. Operational Test: Verify intended operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work. Connect deficiencies, make necessary adjustments and retest. Verify that specified requirements are met.

3.5 CLEANING

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

SECTION 26241 - SWITCHBOARDS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Transient voltage suppression devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.
 - 7. Identification.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings (if requested by Owner) : For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Detail utility company's metering provisions with indication of approval by utility company.
 - 6. Include evidence of NRTL listing for series rating of installed devices.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
 - 2. Obtain switchboards, overcurrent protective devices, components and accessories from approved suppliers.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 2.
- E. Comply with NFPA 70.
- F. Comply with UL 891.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250-W per section) to prevent condensation.
- D. Handle and prepare switchboards for installation according to NEMA PB 2.1.
- E. Use only factory installed lifting provisions.

1.5 PROJECT CONDITIONS

- A. Verify dimensions by field measurements.
- B. Switchboards shall be located to meet or exceed all code clearance repair requirements.
- C. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- D. Environmental Limitations:
 - 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- E. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- F. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner approval.
 - 4. Comply with NFPA 70E.

1.6 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS**2.0 GENERAL REQUIREMENTS FOR SWITCHBOARDS**

- A. Manufacturers: Approved Suppliers.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- D. Nominal System Voltage: Per Construction Documents.
- E. Main-Bus Continuous: Per Construction Documents.
- F. Indoor Enclosures: Steel, NEMA 250, Type 1.
- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's custom color finish over a rust-inhibiting primer on treated metal surface.
- H. Outdoor Enclosures: Type 3R.
 - 1. Finish: Factory-applied finish in manufacturer's custom color; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Downward, sloping roof for each section, with provisions for padlocking.
- I. Barriers: Between adjacent switchboard sections.
- J. Insulation and isolation for main and vertical buses of feeder sections.
- K. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
 - 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch-Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- O. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.
- P. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

- Q. Panelboard Short-Circuit Current Rating:
1. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. Circuit breakers in branch panelboards shall have a minimum 10 kAIC rating. Upstream devices shall be rated at 65 kAIC minimum.
 2. Clearly and legibly mark on the doors of all panelboards "Caution – Series rated system _____ A. available. Identified replacement components required."
- R. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.1 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, as specified on drawings:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
- C. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits.
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. LED indicator lights for power and protection status.
 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- D. Minimum Single-Impulse Current Rating: 80 kA per phase.
- E. Protection modes and UL 1449 SVR Second Edition Revision 2.5 Effective February 2007 for grounded single phase or 120/208 three-phase .

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating or interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-6-mA trip).
 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical or Compression style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity

- discharge (HID) lighting circuits and Type HACR for heating, air conditioning and refrigerant equipment.
- d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- f. Shunt Trip: 120-V trip coil energized from separate circuit.
- B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Fuses are specified in Division 26 Section "Fuses."

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NECA 400.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install switchboards and accessories according to NOMA PB 1.1, NEC, NECA Standards and Manufacturer's written instructions.
- B. Equipment Mounting: Install switchboards on concrete base, specified in Construction Drawings. Comply with requirements for concrete base specified in Division 03 Section.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install filler plates in unused spaces of panel-mounted sections.
- G. Install overcurrent protective devices and transient voltage suppression devices.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Tighten all connections prior to energizing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Switchboard will be considered defective if it does not pass tests and inspections.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable switches and circuit breakers trip ranges.

3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

SECTION 26242 - PANELBOARDS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards rated 600-V and less.
 - 2. Lighting and appliance branch-circuit panelboards rated 600-V and less.
 - 3. Electronic-grade panelboards rated 600-V and less.

1.2 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. GFCI: Ground-Fault Circuit Interrupter.
- C. TVSS: Transient voltage surge suppressor.
- D. RMS: Root Mean Square.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings (if requested by Owner): For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
- C. Qualification Data (if requested by Owner): For qualified testing agency.
- D. Panelboard Schedules (if requested by Owner): For installation in panelboards. Install final versions after load balancing.
- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.4 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain panelboards, overcurrent protective devices, components, and accessories from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (if required) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.6 PROJECT CONDITIONS

- A. Verify dimensions by field measurements.
- B. Panelboards shall be located to meet or exceed all code clearance requirements.
- C. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- D. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- E. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's approval.
 - 3. Comply with NFPA 70E.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.0 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. When required, fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.

- c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 or Type 4X, stainless steel.
- 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 6. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- 7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 - 1. Bus: Tin Plated Aluminum Temp Rated or Copper Temp Rated as required. Provide 750 A per sq. inch Al or 1000 A per sq. inch Cu per local jurisdiction requirements. Bus shall be sequence phased from left to right.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression or Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type.
 - 4. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating:
 - 1. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating. Circuit breakers in branch panelboards shall have a minimum 10 kAIC rating. Upstream devices shall be rated at 65 kAIC minimum.
 - 2. Clearly and legibly mark on the doors of all panelboards "Caution – Series rated system A. available. Identified replacement components required."
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.1 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, as specified on drawings:
- B. Panelboards: NEMA PB 1, power and feeder distribution type.

- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or as specified on drawings.
- E. Branch Overcurrent Protective Devices for all Circuit-Breaker Frame Sizes: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices: Fused switches.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, as specified on drawings:
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating or interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-6-mA trip).
 - 4. Ground-Fault Equipment Protection (GFEF) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits. Type HACR for heating, air-conditioning and refrigeration equipment.
 - d. Ground-Fault Protection: Integrally mounted or Remote-mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
 - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
 - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
 - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, as specified on drawings:
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, non-modular type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

1. Accessories:
 - a. Fuses rated at 200 kA interrupting capacity.
 - b. Integral disconnect switch.
 - c. Redundant suppression circuits.
 - d. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - e. LED indicator lights for power and protection status.
 - f. Audible alarm, with silencing switch, to indicate when protection has failed.
 - g. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
2. Peak Single-Impulse Surge Current Rating: 80 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 40,000 A. (minimum)
 - b. Line to Ground: 40,000 A. (minimum)
 - c. Neutral to Ground: 60,000 A. (minimum)
 - d. Line to Line: 80,000 A. (minimum)
4. Protection modes and UL 1449 SVR Second Edition Revision 2.5 Effective February 2007 for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:
 - a. Line to Neutral: 330 V for 208Y/120.
 - b. Line to Ground: 330 V for 208Y/120].
 - c. Neutral to Ground: 330 V for 208Y/120.
 - d. Line to Line: 600 V for 208Y/120.
 - e. Mcov: 150 V for 208Y/120.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1., NEC, NECA Standards and Manufacturer's written instructions.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1. Comply with NECA 1.
- B. Equipment Mounting: Install panelboards in location indicated on drawings
 1. Install $\frac{3}{4}$ " thick interior grade fire-retardant-treated plywood on wall area before installing panelboard.
 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with panelboard.
 3. Install suitable anchors through plywood and into wood framing or masonry for proper attachment to panelboards.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
- H. Install filler plates in unused spaces.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads [after balancing panelboard loads]; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Panelboards will be considered defective if they do not pass tests and inspections.

3.4 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Project Completion, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

SECTION 26272 - WIRING DEVICES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Wall-box motion sensors.
 - 4. Isolated-ground receptacles.
 - 5. Wall-switch and exterior occupancy sensors.
 - 6. Communications outlets.
 - 7. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
- B. Shop Drawings (if requested by Owner): List of legends and description of materials and process used for pre-marking wall plates.
- C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. All devices used shall be UL listed and installed in compliance with its listing.
- E. All wiring devices shall be of specification grade or greater. Residential grade products shall not be utilized.
- F. All wiring devices shall be as specified within the construction documents and/or as contained herein.

PART 2 - PRODUCTS

2.0 RECEPTACLES

- A. General: Each receptacle shall be constructed to include a grounding pole from which a wired connection to ground shall be provided.
- B. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
 - 1. Receptacles: 15 Amp, 120 Volt NEMA 5-15R, side wired: Hubbell series 5262.
 - 2. Receptacles: 20 Amp, 120 Volt NEMA 5-20R, side wired: Hubbell series 5362.
- C. Locking Receptacles: Heavy-Duty grade, applicable NEMA and UL standards.
- D. GFCI Receptacles (with 4-6mA personnel protection): Straight blade, feed-through type, Heavy-Duty grade, with integral NEMA WD 6, duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a standard 2-3/4-inch deep outlet box without an adapter.
 - 1. GFCI Receptacles: 15 Amp, 120 Volt, NEMA 5-15R GFCI side wired: Hubbell series GF5252.
 - 2. GFCI Receptacles: 20 Amp, 120 Volt, NEMA 5-20R GFCI side wired: Hubbell series GF5352.
- E. Tamper Resistant GFCI Receptacle: Straight blade, "Safelock" protection.
 - 1. 15 Amp, 120 Volt, NEMA 5-15R, Pass & Seymour series 1595 – TRICC4 (Grey)
 - 2. 20 Amp, 120 Volt, NEMA 5-20R, Pass & Seymour series 2095 – TRI (Grey)
- F. Isolated-Ground Receptacles: Straight blade and twist lock, Heavy-Duty grade, single or duplex receptacle, with isolated equipment grounding conductor connected only to the green grounding screw terminal of the device, with inherent electrical isolation from mounting strap, integral to receptacle construction and not dependent on removable parts.
 - 1. IG Receptacles: 15 Amp, 120 Volt NEMA 5-15R IG simplex, side wired: Hubbell series IG5261.
 - 2. IG Receptacles: 15 Amp, 120 Volt NEMA 5-15R IG duplex, side wired: Hubbell series IG5262 or CR5252IG.
 - 3. IG Receptacles: 20 Amp, 120 Volt NEMA 5-20R IG simplex, side wired: Hubbell series IG5361.
 - 4. IG Receptacles: 20 Amp, 120 Volt NEMA 5-20R IG duplex, side wired: Hubbell series IG5362 or CR5352IG.
 - 5. IG Receptacles (Twist lock): 15 Amp, 120 Volt NEMA L5-15R IG simplex, side wired: Hubbell series IG4710.
 - 6. IG Receptacles: (Twist-lock) 15 Amp, 120 Volt NEMA L5-15R IG duplex, side wired: Hubbell series IG4700A.
- G. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- H. Enclosures: NEMA 1 unless otherwise noted.

2.1 TOGGLE SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Toggle switches shall be 120-277 Volt, 20 Amp, side wired with grounding connection: Hubbell series HBL1221.
- C. Snap Switches: Heavy-Duty grade, quiet type, UL 20.
- D. Color: Grey

2.2 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch thick, satin-finished type 302 stainless steel, except as otherwise indicated.

3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Outdoor Wet Locations: Provide UL listed and labeled enclosure that is weatherproof whether or not an attachment plug cap is inserted in the receptacle.
5. Plates for Isolated Ground / Dedicated Circuit Receptacles shall be Hubbell PJ8C0 (1 GANG) and PJ82C0 (2 Gang).

2.3 WALL JACKS

- A. Telephone Jack: Compatible for use with phone system and intended use.
- B. Computer Jack: Compatible for use with computer system and intended use.

2.4 FINISHES

- A. Color:
 1. Wiring Devices Connected to Normal Power System: Grey, unless otherwise indicated or required by NFPA 70.
 2. Isolated-Ground Receptacles: Orange or as specified above, with orange triangle on face.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordination with Other Trades:
 1. Take steps to insure that electrical devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pig-tailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 8. Tighten unused terminal screws on the device.
 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
 10. Install all switches in compliance with ADA requirements.
- E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- H. Adjust locations of floor service outlets and service poles if specified to suit arrangement of equipment being served.

3.1 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. When available, connections shall be made to terminal screws of wiring devices in lieu of utilizing spring or compression back-stab type connections. Connections shall be made utilizing solid copper conductors.

3.2 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

SECTION 26281 - FUSES**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, modular switchgear and enclosed controllers.
 - 2. Spare-fuse cabinets.

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
- B. Submit Fuse Operation and Maintenance Data: Including emergency, operation, and maintenance manuals to Owner:
 - 1. Provide a listing of fuse types and models installed by application to Building Owner/Operator for cross reference in replacement applications.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.4 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.0 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance: 800 Amperes or Greater, Class L, time delay or Class T, fast acting or Class RK or as specified on drawings.
 - 2. Main Feeders 601 Amperes or Greater: Class L, time delay, Class RK5, fast acting, Class RK5, time delay, Class J, fast acting, Class J, time delay or as specified on drawings.
 - 3. Main Feeders 400 - 600 Amperes: Class J, time delay or as specified on drawings.
 - 4. Motor Branch Circuits: Class RK1, time delay or as specified on drawings.
 - 5. Other Branch Circuits Less Than 600 Amperes: Class RK1, time delay or as specified on drawings.
 - 6. Control Circuits: Class CC, time delay or as specified on drawings.
 - 7. Individual Fluorescent Ballast Protection: GLR/HLR type.

3.2 INSTALLATION

- A. Install fuses in fusible devices.
- B. Arrange fuses so rating information is readable without removing fuse.
- C. All fuses shall be of a common manufacturer and of a common type within any fusible device.

3.3 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused device and adjacent to each fuse block, socket, and holder.

SECTION 26282 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and other Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.4 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Obtain enclosed switches and circuit breakers, over-current protective devices, components, and accessories, within same product category, from single source from single manufacturer.
 - 2. Only use approved suppliers.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then

only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner approval.
4. Comply with NFPA 70E.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.0 FUSIBLE SWITCHES

- A. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 6. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.
 7. Service-Rated Switches: Labeled for use as service equipment.

2.1 NONFUSIBLE SWITCHES

- A. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products only from approved suppliers.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I^2t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (5-mA). Personnel protection sensitivity or 30-mA trip equipment protection sensitivity, as required by application.
- I. Features and Accessories:
 1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.3 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products only from approved suppliers.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 1. Standard frame sizes and number of poles.
 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.

3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4 or Type 4X or stainless steel as required.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.
- F. Install disconnect switches and per local utility requirements. Provide suitable supports.
- G. Install disconnect switches and circuit breakers level and plumb.
- H. Connect disconnect switches and circuit breakers and components to building wiring system and ground as indicated in construction documents and as instructed by manufacturer's installation instructions. Installation shall comply with all requirements of the National Electrical Code.

3.2 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots and burrs. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces, chips, scratches, and abrasions to match original finish.

SECTION 26291 - ENCLOSED CONTROLLERS**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.3 SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals including the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
 - 5. Wiring Diagrams: Power, signal and control wiring differentiate between Manufacturers installed and field installed wiring.
- B. Load-Current and Overload-Relay Heater List (if requested by Owner): Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- C. Load-Current and List of Settings of Adjustable Overload Relays (if requested by Owner): Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical systems without Owner approval.
 - 4. Comply with NFPA 70E.

1.7 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.0 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Non Reversing Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Configuration: Non-reversing or as specified on Construction Documents.
 - 2. Surface mounting.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 - 2. Surface mounting.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Non-reversing or as specified on Construction Drawings].

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
3. Surface mounting.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch enclosed controller.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect, Area Construction Manager and Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 CLEANING

- A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

SECTION 26510 - INTERIOR LIGHTING**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

1.2 DEFINITIONS

- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 4. Energy-efficiency data.
 - 5. Life, output, and energy-efficiency data for lamps.
 - 6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings (if requested by Owner): Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Coordination Drawings (if requested by Owner): Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Lighting fixtures.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems for lighting fixtures will be attached.
 - 4. Other items in finished ceiling including the following:

- a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
- 5. Perimeter moldings.
- D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system (if applicable), overhead doors, and partition assemblies.

1.6 WARRANTY

- A. General Warranty: This special warranty specified in this Article shall not deprive the Owner of other rights the owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Eight (8) years from date of Substantial Completion. Full Warranty shall apply for first three (3) years, and prorated warranty for the remaining five years.
- C. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacture specified.

2.1 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Rated lamp life of **50,000** hours.
- F. Lamps, when dimmable, from 100 percent to 0 percent of maximum light output.
- G. Internal driver.

2.4 EMERGENCY POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924 and NFPA 101.
 - 1. Emergency Connection: Operate LED lamp(s) continuously at an output of 600 – 700 lumens each.
 - 2. Night-Light Connection: Operate all LED lamps continuously.
 - 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 4. Battery: 1-1/2 Hour Sealed, maintenance-free, nickel-cadmium type with minimum seven (7) year nominal life. Battery shall have a suitable rating and capacity to supply and maintain at not less than 87.5% of the nominal voltage for the lamp load associated with the unit for a period of at least 1-1/2 hours.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
- B. External Type (retrofit applications only): Self-contained, modular, battery-inverter unit, suitable for powering all LED lamps, remote mounted from lighting fixture. Comply with UL 924.
 - 1. Emergency Connection: Operate LED lamp(s) continuously at an output of 600 – 700 lumens each.
 - 2. Night-Light Connection: Operate all LED lamps in a remote fixture continuously.
 - 3. Battery: Sealed, maintenance-free, nickel-cadmium type, with minimum seven year nominal life. Battery shall have a suitable rating and capacity to supply and maintain at not less than 87.5% of the nominal voltage for the lamp load associated with the unit for a period of at least 1-1/2 hours.
 - 4. Charger: Fully automatic, solid-state, constant-current type.
 - 5. Housing: NEMA 250, Type 1 enclosure, plenum rated where required.
 - 6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.6 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: 1-1/2 hour, sealed, maintenance-free, lead-acid type with minimum 10-year normal life and special warranty. Battery shall have a suitable rating and capacity to supply and maintain at not less than 87.5% of the nominal battery voltage for the lamp load associated with the unit for a period of at least 1-1/2 hours.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures as indicated on Drawings.
 - 8. Provide remote head(s), weatherproof for outdoor applications, as indicated on plans.

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641, Class 3, soft temper, zinc-coated steel, 12 gage minimum.
- D. Wires for Humid Spaces: ASTM A 580, or A 580 M Composition 302 or 304, annealed stainless steel, 12 gage minimum.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
- G. Aircraft Cable Support: Use cable, anchorages and intermediate supports recommended by fixture Manufacturer.

PART 3 - EXECUTION

3.0 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. In seismic areas, install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- C. Suspended Lighting Fixture Support:
 - 1. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- E. Furnish and install all lamp or LED module required, including replacements for non-functioning units, until final acceptance of the completed work. No lighting fixture or sign will be installed without lamps or LED modules.
- F. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Owner who may require that new lamps be installed and fixtures cleaned at the time of turn-over.
- G. Downlight reflectors and parabolic louvers shall be installed in place after the project is completed and dust-free. Installer shall wear white gloves to preclude smudging the reflector surface.
- I. Adjust aimable fixtures to provide required light intensities.
- J. Bond all fixtures to electrical grounding system in accordance with the manufacturer's written instructions and the National Electrical Code.
- K. Install and position emergency lighting unit lamps and remote lamps (as required) to provide foot candle levels required by authority having jurisdiction.
- L. Shielding such as plastic tube shields, plastic sleeves with end caps, shatterproof bulbs and/or other approved devices shall be provided for all artificial lighting fixtures located in areas where a risk of breakage is possible (ie. Less than 8' AFF)
- N. Clean all fixtures after installation. Use methods and materials recommended by manufacturer.

3.1 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.2 CLEANING

- A. Remove all dirt, debris, smudges, etc. from inside and outside of fixture housing as well as lens cover.

SECTION 26560 - EXTERIOR LIGHTING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Poles and accessories.
 - 3. Luminaire lowering devices.

1.2 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Photoelectric relays.
 - 7. Ballasts, including energy-efficiency data.
 - 8. Lamps, including life, output, and energy-efficiency data.
 - 9. Materials, dimensions, and finishes of poles.
 - 10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 - 11. Anchor bolts for poles.
 - 12. Manufactured pole foundations.
- B. Shop Drawings (if requested by Owner):
 - 1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
 - 2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
 - 3. Wiring Diagrams: Power and control wiring.
- C. Pole and Support Component Certificates (if requested by Owner): Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

- D. Qualification Data (if requested by Owner): For agencies providing photometric data for lighting fixtures.
- E. Field quality-control test reports (if requested by Owner).
- F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2, "National Electrical Safety Code."
- D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.6 WARRANTY

- A. General Warranty: This special warranty specified in this Article shall not deprive the Owner of other rights the owner may have under other provisions of the contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: five years from date of Substantial Completion.
 - 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 24 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 24 months from date of Substantial Completion.
 - 5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

- A. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by approved supplier as shown on drawings.

2.1 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials as indicated on drawings.

2.2 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F and higher.
- B. Ballast Characteristics:
 - 1. Power Factor: 90 percent, minimum.
 - 2. Sound Rating: A, except B for T12/HO ballasts.
 - 3. Total Harmonic Distortion Rating: Less than 20 percent.
 - 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
 - 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
 - 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.3 BALLASTS FOR HID LAMPS

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22 deg F.
 - 3. Normal Ambient Operating Temperature: 104 deg F.

4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
- B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.
- C. High-Pressure Sodium Ballasts: Electromagnetic type with solid-state igniter/starter and capable of open-circuit operation without reduction of average lamp life. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
 1. Instant-Restrike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
 - a. Restrike Range: 105- to 130-V ac.
 - b. Maximum Voltage: 250-V peak or 150-V ac RMS.
 2. Minimum Starting Temperature: Minus 40 deg F.

2.4 HID LAMPS

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
 1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36 and hot-dip galvanized according to ASTM A 123; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

PART 3 - EXECUTION**3.0 LUMINAIRE INSTALLATION**

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming.

3.1 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.2 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - b. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

SECTION 27130 – VOICE AND DATA COMMUNICATIONS CABLING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Section 26053 "Raceways and Boxes for Electrical Systems"
- B. Division 26 "Electrical"

1.2 SUMMARY

- A. This Section includes wire, cable, connecting devices, installation, and testing for wiring systems to be used as signal pathways for voice and high-speed data transmission.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. IDC: Insulation displacement connector.
- C. LAN: Local area network.
- D. PVC: Polyvinyl chloride.
- E. STP: Shielded twisted pair.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data (if requested by Owner):
 - 1. Include data on features, ratings, and performance for each component specified.
- B. Shop Drawings (if requested by Owner):
 - 1. Include dimensioned plan and elevation views. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.
- C. Product Certificates (if requested by Owner):
 - 1. For each type of cable, connector, and terminal equipment, signed by product manufacturer.
- D. Manufacturer Seismic Qualification Certification (if requested by Owner): Submit certification that distribution racks and their components will withstand seismic forces defined in Division 26 Section "Seismic Controls for Electrical Work" when required by authority having jurisdiction. Include the following:
 - 1. Basis for Certification: Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based. Indicate whether withstand certification is based on actual test of assembled components or on calculation:
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity of each rack-mounted component and of each assembled rack type, and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Operation and Maintenance Data: For voice and data communication cabling to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: As a minimum the installer must be certified by the termination manufacturer or by Building Industry Consulting Service International (BISCSI).
- B. Source Limitations: Obtain all products except twisted-pair and fiber cables through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of voice and data communication cabling with Owner's telecommunications and LAN equipment suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute to other participants.
 - 3. Adjust arrangements and locations of distribution frames and cross-connect and patch panels in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

PART 2 - PRODUCTS

2.0 SYSTEM REQUIREMENTS

- A. General Requirements: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

2.1 MOUNTING ELEMENTS

- A. Cable Supports: Comply with Division 26 Section "Basic Electrical Materials and Methods."
- B. Raceways and Boxes: Comply with Division 26 Section "Raceways and Boxes."
- C. Backboards: 3/4-inch, interior-grade, fire-retardant-treated plywood.
- D. Distribution Racks: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.

2.2 POS TWISTED-PAIR CABLES, CONNECTORS, AND TERMINAL EQUIPMENT

- A. Cat5 Patch Cables - (8) Eight Conductors.
 - 1. (6-10 cables for printers, server, switch, router, thin clients). The number depends on the number of thin client terminals). One orange (Server DRAC to router), one Green (Server E net to router), One Yellow (Used by wiring tech DSL to router), two blue (Laser printers to Switch), One gray for each remote workstation plus one Gray for the DMARC extension to DSL Modem (used from the biscuit jack to the switch and DSL Modem, installed by the cable installer).
 - 2. Cable is run pin to pin
 - 3. Utilize 1" EMT conduit from main work station computer to DSL terminal.
 - 4. Utilize ½" minimum EMT conduit to each remote POS podium.
- B. Conductors: Solid copper.

- C. Jacks and Jack Assemblies for Cat 5 Cable: Modular, color-coded, RJ-11 receptacle units with integral IDC-type terminals. Use keyed jacks for data service.
- M. Data Outlets: Dual jack-connector assemblies mounted in single or multi-gang faceplate.
 - 1. Faceplate: High-impact plastic.
 - 2. Mounting: Flush, unless otherwise indicated.
 - 3. Legend: Factory labeled, "Voice" and "Data," by silk-screening or engraving.

2.3 IDENTIFICATION PRODUCTS

- A. Comply with Division 26 Section "Identification for Electrical Systems" and the following:
 - 1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

PART 3 - EXECUTION

3.0 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, cable supports, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1 INSTALLATION

- A. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, and counters and except in accessible ceiling spaces where unenclosed wiring supports method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
- B. Install cables using techniques, practices, and methods that are consistent with Category 5 rating of components and that ensure Category 5 performance of completed and linked signal paths, end to end.
- C. Install cables without damaging conductors, shield, or jacket.
- D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- E. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.
- F. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
- G. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- H. Wiring within Wiring Cabinets and Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- I. Separation of Wires: Comply with TIA/EIA-569-A rules for separating unshielded copper voice and data communication cabling from potential EMI sources, including electrical power lines, conduits, lighting fixtures, motors, transformers, and other electrical equipment.
- J. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
- K. Use splice and tap connectors compatible with media types.

3.2 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding."
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Signal Ground Terminal: Locate in each cabinet and enclosure; isolate from power system and equipment grounding.

3.3 INSTALLATION IN EQUIPMENT ROOMS

- A. Install plywood backboards on wall of equipment room(s).
- B. Mount patch panels, terminal strips, and other connecting hardware on backboards, unless otherwise indicated.
- C. Group connecting hardware for cables into separate logical fields.
- D. Use patch panels to terminate cables entering the space, unless otherwise indicated.

3.4 INSTALLATION STANDARDS

- A. Comply with requirements in TIA/EIA-568-A and TIA/EIA-569-A.

3.5 IDENTIFICATION

- A. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems " and TIA/EIA-606.
- B. Data jack location: Label cables within outlet boxes.
- C. Distribution Cabinets, Racks, Enclosures and Frames: Label each unit and field within that unit.
- D. Within Connector Fields in Equipment Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Cables, General: Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- F. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
- G. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover.
- H. Use jacket color coding standard for cabling serving different functions such as voice, data, security, and video.

3.6 CLEANING

- A. On completion of system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.7 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

2. Copper Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bi-directional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-TSB67, "Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems." Link performance for UTP cables must meet minimum criteria of TIA/EIA-568-A.
 3. Fiber-Optic Cable Procedures: Perform each visual and mechanical inspection and electrical test, including optional procedures, stated in NETA ATS, Section 7.25. Certify compliance with test parameters and manufacturer's written recommendations. Test optical performance with optical power meter capable of generating light at all appropriate wavelengths.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

SECTION 31000 - EARTHWORK**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Section 31100 - Site Clearing
- B. Section 32930 - Landscaping
- C. Section 31231 – Rock Removal

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for slabs-on-grade.
 - 4. Subbase course for concrete walks and pavements.
 - 5. Subbase and base course for asphalt paving.
 - 6. Subsurface drainage backfill for walls and trenches.
 - 7. Excavating and backfilling for utility trenches.
 - 8. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner. Unauthorized excavation, as well as remedial work directed by Owner, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by an independent geotechnical testing agency, according to ASTM D 1586.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 PRODUCTS

2.0 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter and possessing an Atterberg plasticity index between 4 and 15 percent, with a liquid limit of 35 percent or less.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.1 ACCESSORIES

- A. Warning Tape: Acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities.

PART 3 EXECUTION

3.0 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.

3.1 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.2 GENERAL

- A. Perform earthwork in compliance with applicable codes and standards and governing authorities having jurisdiction.
- B. Soils, Testing, and Inspection Service. The General Contractor shall engage a Registered Soils Engineer for continuous inspections and quality control testing during all earthwork and dewatering operations. Refer to Geotechnical Report for additional information.
- C. Various utilities exist on this site. Known utilities are noted on the drawings. This Contractor shall contact local utility companies to verify the location of any underground utilities before earthwork is started. Protect all overhead and underground utilities on the site and along the rights-of-ways and neighboring facilities at all times.
- D. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation (work), consult Utility Company immediately for directions. Cooperate with Owner and Utility Companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of Utility Company.
- E. Do not interrupt existing utilities serving the existing facility, except when permitted in writing and then only after acceptable temporary utility services have been provided.
- F. The General Contractor shall establish permanent benchmarks. The Earthwork Contractor shall maintain and protect these permanent benchmarks on the site for future construction on the site. Location of benchmarks shall be approved by the Owner's Representative. The Contractor shall provide base lines, levels, and grade stakes for work under this Section. Accuracy of such lines, levels, locations, benchmarks, and grades shall remain the General Contractor's responsibility.
- G. The Earthwork Contractor shall provide a system of drainage ditches, pumps, and lines or other approved methods to limit free water seepage into fill or compacted areas. It is important to note that soil materials on this site will be damaged by exposure to standing water. Therefore, all precautions must be taken to limit standing water and seepage during the construction period.
- H. Use only soil materials approved by the Owner's soils testing and inspection service in fill and cut areas. Unsatisfactory soil materials not approved for fill or compaction shall be removed from the site. Any unacceptable excavated material, trash, and debris shall be disposed of off the Owner's property in an approved manner.

3.3 DETAILED REQUIREMENTS

- A. Prior to start of any excavation, cut, and/or fill work, proof roll areas to receive fill to determine soft and/or unstable areas. Undercut, backfill, and compact such areas as directed by Owner's Representative and/or Soils Engineer.
- B. Compaction:
 - 1. Control soil compaction during construction. Provide minimum percentage of density specified for each area. Compact soil to not less than the following percentages of maximum dry density in accordance with ASTM D-698, "Standard Proctor Method for Compacting and Density of Soil."
 - a. Building area and slabs on grade: 100% of maximum dry density.
 - b. Paved road, dock areas, and parking areas: 100% of maximum dry density.
 - c. Lawn or unimproved areas: 90% of maximum dry density.
- C. Moisture Control:
 - 1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material to obtain proper moisture content to properly compact materials.
 - 2. Remove and replace, or scarify and air dry, soil materials that are too wet to obtain the degree of compaction required.
- D. Excavation, Earth Cut, and Fill Work:
 - 1. Excavated and cut material approved by the Owner's soil testing and inspection service as approved fill material shall be deposited, spread uniformly and compact to the proper density.
 - 2. Prior to start of excavation work, a sample of excavated material to be used for fill shall be submitted to the Soils Testing Engineer for approval.
 - 3. Offsite fill material shall be submitted to the Soils Engineer for approval. Place fill materials in layers not exceeding 12" in loose form prior to compaction.
 - 4. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density.
 - 5. Do not place fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - 6. Earth cut and excavated material used for fill material shall be free from vegetable matter, rubbish, large rock, or other deleterious material not approved by the Soils Engineer. Any material to be used for fills shall first be approved by the Soils Engineer.
 - 7. Grade finished subgrade surfaces, free from irregular surface changes, to within plus or minus 0.1' subgrades required by the drawings. Subgrade Elevations:
 - a. Concrete paved areas: 12" below top of concrete paving.
 - b. Interior floor slabs: 12" below top of finished slabs.
 - c. Lawn areas: 6" below finish grade.
- E. Foundation Excavation:
 - 1. Foundation excavation consists of removal and disposal of material encountered when establishing required footing grade elevations.
 - 2. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner. Unauthorized excavation as well as remedial work directed by the Owner shall be at Contractor's expenses.
 - 3. Under footings or foundation bases, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to the Owner.
 - 4. Elsewhere backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Owner.
 - 5. Additional Excavation: When excavation has reached required subgrade elevations, notify Owner's Soils Engineer who will make an inspection of conditions. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by the Owner's Soils Engineer. Removal of unsuitable material and its replacement as directed will be paid on the basis of unit price approved by the Owner's Project Engineer.
 - 6. Stability of Excavations: Slope side of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions

- or stability of material excavated. Provide materials that comply with local codes and authorities having jurisdiction.
7. Maintain sides and slopes of excavation in safe condition until completion of backfilling.
 8. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding areas.
 9. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 10. Excavation for Structures. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 ft., and extending a sufficient distance from fittings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 11. In excavating for footings and foundations, take care not to disturb bottom of excavation. Trim bottoms to required lines and grades to leave solid base to receive other work.
- F. Distribution of Topsoil:
1. Disc subgrade to a depth of 2" to 3", removing stones and clods over 2" in diameter prior to spreading topsoil.
 2. Topsoil, taken from on site stockpile, shall be distributed in minimum 6" layer over all areas disturbed by construction and/or noted on drawings to receive topsoil.
 3. Bring topsoil at least 1" above paved areas and final grade lines.
 4. Hand dress surface to a smooth, even grade, removing all stones and clods over 1" in diameter.
- Sod:
1. Contractor shall sod all existing areas damaged by construction and all areas where topsoil has been distributed. Sod, and fertilizer, shall be approved by the owner's Representative.
 2. Sod type: as specified on drawings or recommended from local extension service. A Tall Turf-Type fescue should be used in most lawn applications unless otherwise specified. Sod mix should be 80% to 100% germination.
 3. Fertilizer: Commercial 10-10-10, distributed 20 lbs. per 1,000 sq. ft.

SECTION 31100 - SITE CLEARING**PART 1 - GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Protecting existing trees to remain.
 - 2. Removal of designated trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above- and below-grade site improvements.
 - 6. Disconnecting, capping or sealing, and removing site utilities.
 - 7. Temporary erosion and sedimentation control measures.
- B. Related Sections include the following:
 - 1. Section 02060 "Demolition" for demolition of buildings, structures, and site improvements.
 - 2. Section 31000 "Earthwork" for soil materials, excavating, backfilling, and site grading.

1.2 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Owner's Representative.
- C. Utility Locator Service: Notify utility locator service for location of utilities before site clearing.

- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.0 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31000 "Earthwork."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.0 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to a sediment and erosion control plan, specific to the site, complying with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.
 - 1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.

2. Replace trees that cannot be repaired and restored to full-growth status, as determined by arborist.

3.3 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving adjacent facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Owner approval.
- C. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 4. Use only hand methods for grubbing within tree protection zone.
 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground or specified compaction requirements if in build zone.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Limit height of topsoil stockpiles to 72 inches.
 2. Do not stockpile topsoil within tree protection zones.
 3. Dispose of excess topsoil as specified for waste material disposal.
 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.6 SITE IMPROVEMENTS

- A. Remove existing above and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 1. Unless existing, full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

SECTION 31231 – ROCK REMOVAL**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

Earthwork: Section 31000

1.2 UNIT PRICES FOR ADDED OR DEDUCTED WORK

- A. Do not exceed the quantities of rock removal indicated by numeric units on the Drawings, except by Order on Contract. In order to avoid delay, notify the Owner's Representative when the amount of completed Work approaches the quantity indicated.
- B. If the removed quantity of rock is greater than the numeric units of Work indicated on the Drawings, the contract sum will be adjusted by an Order on Contract. If the removed quantity of rock is less than the numeric units of Work indicated on the Drawings, the contract sum will be adjusted via a Supplemental Agreement (BDC 134) at time of final payment at the following unit prices:
1. Added General Rock Removal @ \$ _____ per cu yd.
 2. Deducted General Rock Removal @ \$ _____ per cu yd.
 3. Added Trench and Pier Rock Removal @ \$ _____ per cu yd.
 4. Deducted Trench and Pier Rock Removal @ \$ _____ per cu yd.
- D. The foregoing unit prices include test pits, overhead, profit, and all other expenses incidental to the Work. Include in the bid sum all additional costs in connection with quantity changes that are not compensated for at the given unit prices.
- E. The unit price for additional rock removal is over and above the cost of earth excavation. No deduction from the bid sum will be taken for reduced quantities of earth excavation resulting from additional rock removal.
- F. The unit price for deducted rock removal takes into account and is deemed to compensate for the cost (including overhead, profit and all other expense items) of earth excavation in lieu of rock removal. No additional payment will be made for such additional earth excavation.
- G. If the total amount of a change exceeds 20 percent of the aforementioned quantity indicated on the Drawings, the adjustment of the contract sum for the quantity in excess of 20 percent will be made in accordance with the General Conditions.
- H. Measurement: Rock quantities will be determined by measuring rock in place prior to removal. Measurements shall be taken of the actual rock cut, as required for the Work, or to the specified measurement limits, whichever is smaller. Unless otherwise directed in writing, measurement limits shall be as follows:
1. Cast-In-Place Concrete:
 - a. Vertical Limit: Bottom of rock cut for cast-in-place concrete bearing on rock shall be the bottom of concrete elevation indicated on the Drawings.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 3 Feet	18 Inches
3 to 15 Feet	24 Inches
Over 15 Feet	30 Inches

2. Precast Concrete Structures: Measurement will be based on the size of the precast concrete structure specified or indicated on the Drawings.
 - a. Vertical Limit: Bottom of rock cut for precast concrete structure shall be 12 inches below the required bottom of structure elevation.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 5 Feet	12 Inches
5 to 15 Feet	18 Inches
Over 15 Feet	24 Inches

3. Pipe:
 - a. Vertical Limit: Bottom of rock cut for pipe in trench shall be 6 inches below the required pipe invert elevation, with depth measured from the mean surface of the rock.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Trench Width
Under 10 Feet	24 Inches plus Pipe OD
10 to 15 Feet	36 Inches plus Pipe OD
Over 15 Feet	48 Inches plus Pipe OD

4. Conduit:
 - a. Vertical Limit: Bottom of rock cut for conduit in trench shall be as required for the indicated depth of the conduit.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Trench Width
Under 3 Feet	24 Inches, except where wider width is required by the multiple horizontal conduits.
3 to 10 Feet	36 Inches, except where wider width is required by the Drawings or directed for multiple horizontal conduits.

5. Foundation Drains: Where drains and foundation share the same rock cut, the horizontal measurement limit, on the drain side of the footing, shall be 30 inches from edge of concrete to vertical side surface of rock at bottom of cut unless otherwise shown on the Drawings.

1.3 REFERENCES

- A. Comply with the applicable requirements of the Code of Federal Regulations Title 29 - Labor, Part 1926 Safety and Health Regulations for Construction (OSHA).

1.4 DEFINITIONS

- A. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by ripping, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
 1. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation. Concrete building foundations and concrete slabs,

- where indicated, shall be classified as earth excavation. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.
- B. Unauthorized Rock Removal: The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.
 - C. General Rock Removal: Quantities of rock removal will be paid for as General Rock Removal when:
 - 1. The width of rock removed, as per measurement limits, is greater than or equal to the total excavation depth required.
 - 2. Boulders removed have a volume greater than 1.0 cu yd.
 - D. Trench and Pier Rock Removal: Quantities of rock removal will be paid for as Trench and Pier Rock Removal when the width of rock removed, as per measurement limits, is less than the total excavation depth required.

1.5 SUBMITTALS

- A. Rock Removal Procedure (if requested by Owner): Submit a detailed outline of intended rock removal procedure. This submittal will not relieve the Contractor of responsibility for the successful performance of method used.
- B. Quality Control Submittals (if requested by Owner):
 - 1. Certificates: Competency affidavit required under
 - a. Name, and employer's name, business address and telephone number.
 - b. Names and addresses of the required number of similar projects which meet the experience criteria.
- C. Measurement data for quantities of rock removal.

1.6 QUALITY ASSURANCE

- A. Pre-Rock Removal Conference: Before the rock removal work is scheduled to commence, a conference will be called by the Owner's Representative at the site for the purpose of reviewing the Contract Documents and discussing requirements for the Work. The conference shall be attended by the Contractor's Representative and the person supervising the rock removal operations.

1.07 PROJECT CONDITIONS

- A. Blasting and the use of explosive materials will not be permitted. Keep proper daily records, including drilling logs, disposal manifests, etc.
- C. Obtain photos, and other related structural data of nearby structures to record and measure impact of removal operations.

PART 2 PRODUCTS

2.0 MATERIALS

- A. Backfill Materials and Other Related Earthwork: As specified in Section 31000.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examination of Existing Property and Construction: Prior to starting rock removal Work, thoroughly examine the existing property and construction at the site and record, with notes and drawings or other documentation, existing defects and deterioration. Make this information available to the Director's Representative upon request.

- B. Measure and record condition of existing foundation walls, building interior walls and ceiling, exterior masonry, glass, etc. prior to excavation procedures.

3.1 ROCK REMOVAL

- A. Remove rock as required by the Drawings and as necessary for the installation of the Work. Make sufficient clearance, within the limits specified, for the proper execution of the Work.

3.2 FIELD QUALITY CONTROL

- A. Notify the Owner's Representative at least 3 work days in advance of all phases of rock removal.
- B. Allow time for visual inspection of bottom of rock cut required for the Work.

3.4 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS.

- A. Remove and dispose of excess and unsuitable rock materials.

3.6 CLEANING

- A. Where footings and walls will rest entirely on rock, clean rock surfaces free of soil and loose rock.
- B. Clean neighboring properties affected by excavation and removal procedures.

SECTION 31330 – GEOTEXTILES / GEOMATRIXES**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

- A. Geogrid installation
- B. Soil/granular fill placement over geogrid

1.2 RELATED WORK

- A. Section 31000 – Earthwork
- B. Geotechnical Evaluation – if available

1.3 SUBMITTALS

- A. Product Data (if requested by Owner):
 - 1. Samples of specified product.
- 2. Test certificates verifying the following:
 - a. Tensile Test
 - 1) Uniaxial (if applicable)
 - 2) Biaxial (if applicable)
 - b. Creep Test

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The contractor shall check the geogrid, upon delivery, to assure the proper material has been received.
- B. Special care shall be taken in the handling of geogrids manufactured from polypropylene at temperatures at or below 0 degrees F.

PART 2 PRODUCTS**2.0 DEFINITIONS**

- A. Geogrid: a polymer grid structure is manufactured from a punched polypropylene sheet, oriented in multiple, equilateral directions to form a triangular aperture, delivering high radial stiffness throughout the full 360 degrees specifically fabricated for use as a soil reinforcement.
- B. Biaxial grid: a geogrid which has been manufactured using select grades of polypropylene or copolymers that resist high, short-term dynamic loads or moderate loads over longer time periods. These products carry loads applied in any direction in the plane of the geogrid.

2.1 ACCEPTABLE MANUFACTURERS

- A. The geogrid shall be Tensar Triax Geogrid as shown on engineering plans and as manufactured by the Tensar Corporation, Morrow, Georgia.
- B. Biaxial grid shall be Tensar Biaxial bx Geogrid as shown on engineering plans and as manufactured by the Tensar Corporation, Morrow, Georgia.

PART 3 EXECUTION**3.0 SUBGRADE SOIL PREPARATION**

- A. Subgrade soil shall be prepared as indicated on the construction drawings and as directed by the Owner's Representative.
- B. All sharp objects and any boulders shall be removed from the subgrade surface prior to placement of the geogrid.

3.1 GEOGRID INSTALLATION

- A. Geogrid shall be laid at the proper elevation and alignment as shown on the construction drawings.
- B. Geogrid shall be oriented such that the roll length runs parallel to the road direction.
- C. Overlaps:
 - 1. Geogrid sections shall be overlapped as indicated on the construction drawing or as recommended by manufacturer.
 - 2. Minimum overlap is 1 foot.
- D. Geogrid sections shall be joined along overlaps at intervals of 10 feet with wire or plastic ties wrapped around a web from each roll.
- E. Geogrid material shall be tensioned by hand and secured to the ground surface by:
 - 1. Staking at 10 foot intervals by use of 6" soil pins; or
 - 2. Placement of loose fill at the corners and edges; or
 - 3. Per manufacturer's recommendations.
- F. Care shall be taken to ensure that geogrid sections do not separate at overlaps during construction.
- G. Placement of geogrid around corners will require cutting of geogrid product and diagonal overlapping of same to ensure that excessive bulking of grid material does not occur.

3.2 SOIL GRANULAR FILL PLACEMENT OVER GEOGRID

- A. Soil granular fill material shall be placed in lift thicknesses and compacted as directed under Section 31000.
- B. Granular fill material shall be back dumped from trucks riding on top of the reinforced fill and bladed onto geogrid in such a manner that the fill rolls onto the grid ahead (e.g. by gradually raising dozer blade while moving forward).
- C. Tracked construction equipment shall not operate directly upon the geogrid. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid.

SECTION 32120 – ASPHALT PAVING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Geotechnical Soils Report (if applicable)
- B. Division 31 - Earthwork
- C. Section 09910 - Painting: For pavement marking materials

1.2 SECTION INCLUDES

- A. Base course.
- B. Hot-mixed asphaltic concrete.
- C. Coal-Tar Sealer
- D. Pavement marking.

1.3 SYSTEM DESCRIPTION

- A. Aggregate base design:
 - 1. Provide paving design per specified materials in the following thicknesses:
 - a. Base Course: 8" crushed stone.
 - b. Binder Course: 1 1/2" of asphaltic concrete.
 - c. Surface Course: 1" of asphaltic concrete.
- B. Full depth asphalt design (Contractor shall submit an alternate bid stating the amount to be added to or deducted from his bid for substitution of full-depth asphalt in lieu of aggregate base design.):
 - 1. Provide paving design per specified materials in the following thicknesses:
 - a. Base Course: 4 1/2" of asphaltic concrete.
 - b. Surface Course: 2" of asphaltic concrete.

1.4 PROJECT CONDITIONS

- A. Application Requirements:
 - 1. Apply tack coats only when ambient temperature is above 50 degrees F., and when temperature has not been below 35 degrees F., for 12 hours immediately prior to application. Do not apply when base is wet.
 - 2. Construct asphalt surface course only when atmospheric temperature is above 40 degrees F., and when asphalt base is dry and clean. Asphalt base course may be placed when air temperature is above 30 degrees F., and rising and when aggregate base is dry.

PART 2 PRODUCTS**2.1 MATERIALS**

- A. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations.

- B. Base Course: 100 percent crushed stone, gradation for dense-graded aggregate as required by applicable the State Highway Department.
- C. Asphalt Materials: Materials and application shall conform to the Department of Transportation specifications of the State in which the work is done, for Class I Type B Hot-Mix asphaltic concrete. Hot-Mix materials shall develop a minimum of 750 pounds stability, and a flow value between 8 and 16.
- D. Tack Coat: Cutback asphalt, RC-250.
- E. Coal-Tar Sealer: Material must be fuel resistant in field use conforming to ASTM-D490, Grade 12; ASTM D20 (% by weight to 300, Max. 60); ASTM-D36 (65 Max.)

PART 3 EXECUTION

3.0 PREPARATION

- A. Verify elevations of rough grade work. Remove, reshape, or provide sufficient material where necessary to provide required thickness of base and bituminous areas. Remove rutted areas or windrowing resulting from truck traffic.
- B. Subgrade preparation under the aggregate base shall conform to the Department of Transportation Specifications. This work shall be done after unstable sections of the subgrade have been repaired and after existing base and surface courses required to be removed have been removed.
- C. The required density of the subgrade shall be 95% of the maximum standard Proctor density in the upper 36" below the paving.

3.1 PROTECTION

- A. Protect concrete flatwork, curbs landscaping, building walls, etc. from spatters, wheel and track marking, rollers, and any other damages that could occur from this work.
 - 1. Apply a layer of sand on flat concrete surfaces to protect from tack smears and tire and track marks.
- B. Keep hot asphalt in transport trucks covered with tarps from plant to site.

3.2 PLACING AGGREGATE BASE COURSE

- A. Apply over the compacted subgrade, the aggregate base of the thickness and material specified in two equal lifts.
 - 1. Stone used during construction as a temporary base shall not be included in the thickness required for base.
 - 2. The aggregate base shall be compacted to minimum 95% of the modified Proctor density.
 - 3. The finished surface of the aggregate base course shall not vary more than 0.05 feet from the elevations, grades and cross-sections shown on the Drawings.
 - 4. After base is completed, it shall be proof-rolled and checked by Owner's Representative before placement of Bituminous paving.

3.3 PLACING ASPHALT BINDER AND SURFACE COURSES

- A. General:
 - 1. Place bituminous mixture on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 225 degrees F. Place inaccessible and small areas by hand. Place each course to required grade, cross section, and compacted thickness. The mix shall be placed and rolled in accordance with state specifications and as specified herein.
 - 2. Placing: Place in strips not less than 10 feet wide, unless area configuration does not allow. After first strip has been placed and rolled, place succeeding strips and

- extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
- a. Joints: Make joints between old and new pavements, and between successive day's work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.
 - b. Tack Coat: Apply to contact surfaces of previously constructed asphalt binder course and joints. Place at a consistency of approximately 0.05 gal./sq. yd. Allow to dry until at proper condition to receive paving.
3. Rolling: Begin rolling when mixture will bear roller weight without excessive displacement.
- a. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
 - b. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.
 - c. Second Rolling: Follow breakdown rolling with second rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
 - d. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and the course has attained recommended maximum density.
 - e. After finish rolling, erect barricades to protect paving from traffic until mixture has cooled and attained its maximum degree of hardness.
 - f. Compact surface course to 95% of the maximum Marshall dry density.

3.4 COAL-TAR SEALER APPLICATION

- A. The coal-tar sealer shall be applied only when the existing surface is dry and the pavement surface temperature is above 50 degrees F and rising, but below 90°F for application. Do not over apply, which will result in tracking. Do not apply if rain or cold temperatures are expected within 36 hours.
- B. The Contractor shall furnish all equipment, tools, and machines necessary for the performance of the work.
 1. Pressure Distributor: The distributor shall be designed, equipped, maintained, and operated so that coal-tar sealer at even heat may be applied uniformly on variable widths of pavement at the specified rate.
 2. Power Broom: A power broom and/or blower shall be provided for removing loose material from the pavement surface.
- C. Prior to placing the sealer, the surface of the pavement shall be clean and free from dust, dirt, or other loose foreign matter with a power broom. Properly treat oil spots with Petro Seal spot cleaner.
- D. Fill structural cracks with a hot pour crack sealant or flexible cold applied sealant such as FlexMaster and follow manufacturer's recommendations.
- E. Mix well. Equipment shall have continuous agitation or mixing capabilities to maintain homogeneous consistency of pavement sealer mixture throughout the application process.
- F. An early cure additive may be necessary to meet curing requirements for opening of facility for business. Consult Owner
- G. Complete the entire driveway in one continuous application to prevent "color shading".
- H. Apply Sealmaster Coal Tar Emulsion Sealant exceeding Federal Specs RP-355E regulations at the rate of .20 gallons per square yard. Sealer contains 1% rubberized latex additive and fractured silica sand at the rate of 2 pounds per gallon."

- I. Sealer should be applied by either pressurized spray application equipment or self-propelled squeegee equipment. Pressurized spray equipment should be capable of spraying pavement
- I. Following the application, the surface shall be allowed to cure without being disturbed until the sealer has dried out. Suitable precautions shall be taken by the Contractor during this period, including the application of any sand necessary to blot up excess material.
- J. Check with Owner if a two-coat application is required.

3.5 PAVEMENT MARKING

- A. Layout parking spaces and traffic lines as shown and provide such incidental pavement marking as directed. Perform marking after surface course has been completed and before traffic is allowed on the pavement insofar as practicable.
 - 1. New pavement surfaces shall be allowed to cure for a period of not less than 20 days before application of marking materials, unless otherwise approved by the Owner's Representative.
- B. Surfaces to be marked shall be thoroughly cleaned before application of the paint.
 - 1. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required.
- C. Paint Application: The equipment for applying paint to pavements shall be a pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results.
 - 1. Rate of Application: Paint shall be applied evenly to the pavements surface to be coated at a rate of 400 s.f. per gallon. Striping shall be 4" in width.
 - 2. Paint shall be applied in 1 (one) coat.
 - 3. Markings shall be white, except blue in handicap stalls and yellow in service road. Refer to Division 9 Exterior Paint for product information.
 - 4. Paint shall be applied only when the air and pavement temperatures are above 40 degrees F. and less than 95 degrees F. Edges of markings shall be sharply outlined.
 - 5. Furnish temporary barriers until pavement markings have dried.

3.6 FIELD QUALITY CONTROL

- A. Compaction of paving subgrade and aggregate base shall be under the supervision of the testing laboratory.
- B. Thickness: In-place compacted thickness will not be acceptable if exceeding following allowable variation from required thickness:
 - 1. Aggregate Base Course: 1/2", plus or minus.
 - 2. Asphaltic Concrete Binder and Surface Courses: 1/4", plus or minus.
- C. Surface Smoothness: Test finished surface of surface course for smoothness using a 10 foot straightedge applied parallel with and at right angles to centerline of paved area. Surface will not be acceptable if it exceeds a 3/16" tolerance for smoothness.
- D. If the above test indicate that Specifications have not been met, the Contractor shall pay for such additional tests as may be required to assure that compliance has been attained.
- E. If Owner elects, specimens shall be removed at locations designated by the Owner's Representative, and care shall be exercised to avoid damage to the specimens. The holes caused by the removal of the specimens shall be refilled by the Contractor immediately with an asphaltic material meeting these Specifications, compacted and finished to the satisfaction of the Owner, without additional cost to the Owner.

3.7 CLEAN-UP

- A. Remove all spatters, loose granuals, excess asphalt etc., from facility.
- B. Thoroughly remove dirt and contaminants resulting from application of driveway or from other trades.

SECTION 32130 - PORTLAND CEMENT CONCRETE PAVING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SUMMARY

- A. This Section specifies concrete paving, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
- B. Related Sections include the following:
 - 1. Geotechnical Report if applicable
 - 2. Division Section 03100 Concrete Formwork
 - 3. Division Section 03200 Concrete Reinforcing
 - 4. Division Section 03300 Cast-in-Place Concrete
 - 2. Division Section 31200 "Earth Moving" for drainage fill under slabs-on-grade.

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

- A. Product Data (if requested by Owner): For each type of product indicated.
- B. Design Mixtures (if requested by Owner): For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Welding certificates (if requested by Owner).
- D. Qualification Data (if requested by Owner): For Installer and testing agency.
- E. Material Test Reports (if requested by Owner): For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- F. Material Certificates (if requested by Owner): For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Fiber reinforcement.
 - 6. Curing compounds.
 - 7. Floor and slab treatments.
 - 8. Bonding agents.
 - 9. Adhesives.
 - 10. Vapor retarders.
 - 11. Semirigid joint filler.
 - 12. Joint-filler strips.

- 13. Repair materials.
- G. Field quality-control test and inspection reports (if requested by Owner).

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 2. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 - 3. ACI 318, "Building Code Requirements for Structural Concrete."
- F. Concrete: Comply with Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
 - 1. Materials and mixes to perform quality control testing where required by Project Manager in accordance with General Conditions.
 - 2. Provide the services of a testing laboratory to design concrete mixes.
 - 3. Testing agency shall meet the requirements of ASTM E329.
 - 4. Selection of a testing laboratory is subject to the Project Manager's acceptance.
 - 5. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information as may be requested by the Project Manager.
- H. Tests for Concrete Materials:
 - 1. For normal weight concrete, test aggregates by the methods of sampling and testing of ASTM C33.
 - 2. For Portland Cement, sample the cement and determine the properties by the methods of test of ASTM C150.
 - 3. Submit written reports for each material sampled and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not materials are acceptable for intended use.
- J. Certificates of material properties and compliances with specified requirements may be submitted in lieu of testing, when acceptable to the project Manager. Certificates of Compliance must be signed by the materials producer and the Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

PART 2 - PRODUCTS**2.0 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 1 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C 330, 1/2-inch nominal maximum aggregate size.
- E. Water: ASTM C 94 and potable.

2.2 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494, Type A.
 - 2. Retarding Admixture: ASTM C 494, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494, Type C.
 - 1. Products:
 - a. Euclid Chemical Company; Eucon CIA.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI.
 - c. Master Builders, Inc.; Rheocrete CNI.
 - d. Sika Corporation; Sika CNI.
- D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - 1. Products:
 - a. Cortec Corporation; MCI 2005NS.
 - b. Grace Construction Products, W. R. Grace & Co.; DCI-S.
 - c. Master Builders, Inc.; Rheocrete 222+.

- d. Sika Corporation; FerroGard-901.

2.3 FIBER REINFORCEMENT

- A. Carbon-Steel Fiber: ASTM A 820, deformed, minimum of 1.5 inches long, and aspect ratio of 45 to 50.
 - 1. Products:
 - a. Bekaert Corporation; Dramix.
 - b. Fibercon International, Inc.; Fibercon.
 - c. SI Concrete Systems; Zorex.
 - 2. Fiber: Type 2, cut sheet.
- B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 3/4 inches long.
 - 1. Products:
 - a. Fibrillated Fibers:
 - 1) Euclid Chemical Company; Fiberstrand F.
 - 2) Grace Construction Products, W. R. Grace & Co.; Grace Fibers.
 - 3) SI Concrete Systems; Fibermesh.

2.4 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
 - 1. Products:
 - a. Fortifiber Corporation; Moistop Plus.
 - b. Raven Industries Inc.; Dura Skrim 8.
 - c. Reef Industries, Inc.; Griffolyn Type 85.
 - d. Stego Industries, LLC; Stego Wrap, 10 mils.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.5 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products:
 - a. ChemMasters; Spray-Film.
 - b. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - c. Dayton Superior Corporation; Sure Film.
 - d. Euclid Chemical Company; Eucobar.
 - e. L&M Construction Chemicals, Inc.; E-Con.
 - f. Meadows, W. R., Inc.; Sealtight Evapre.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Products:
 - a. ChemMasters; Safe-Cure Clear.
 - b. Conspec Marketing & Manufacturing Co., a Dayton Superior Company; W.B. Resin Cure.
 - c. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - d. Euclid Chemical Company; Kurez DR VOX.
 - e. L&M Construction Chemicals, Inc.; L&M Cure R.
 - f. Meadows, W. R., Inc.; 1100 Clear.
 - g. Tamms Industries, Inc.; Horncure WB 30.

2.6 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.0217-inch thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336-inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.7 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
 - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 - 5. Silica Fume: 10 percent.
 - 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 - 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- F. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

2.8 STEEL REINFORCEMENT

- A. Welded Wire Mesh. 6 x 6 x 2/2 @ .78/sf welded wire mesh, flat sheets. Install in all pavement area concrete. Install in center of slab. Secure reinforcing mesh in position using standard metal supports, spacers, and ties. Mesh to be ASTM A-185.
- B. Reinforcing Bars. Deformed steel bars, ASTM A 615, Grade 40.
- C. Joist Dowel Bars. Plain steel bars, ASTM A 615, Grade 40. Cut bars true to length with ends square and free of burrs.
- D. Metal Expansion Caps. Furnish for one end of each dowel bar in expansion joints. Design caps with one end closed and a minimum length of 3" to allow bars movement of not less than 1", unless otherwise indicated.
- E. Dowel Baskets. Equal to metal dowel baskets as manufactured by the Dayton Sure Grip and Shores Company.

PART 3 EXECUTION

3.0 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.1 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
 1. Lap joints 12 inches and seal with manufacturer's recommended tape.

3.2 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 4. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof

- abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, and other locations, as indicated.
1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.3 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Comply with ACI304, "Guide For Measuring, Mixing, Transporting and Placing Concrete," and as specified.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Owner's Representative.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleed-water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- H. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.4 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view, to be covered with a coating or covering material applied directly to concrete.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.5 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings
- C. Trowel Finish: Interior slabs only. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated, exposed to view or to be covered with ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 2. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-foot- long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch
- D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated where ceramic or quarry tile is to be installed. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Owner's Representative before application.

3.6 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
 - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.7 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.9 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Owner. Remove and replace concrete that cannot be repaired and patched to Owner's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalling, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Owner's representative.

3.10 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Contrator will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Verification of use of required design mixture.
 - 4. Concrete placement, including conveying and depositing.
 - 5. Curing procedures and maintenance of curing temperature.
 - 6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 3. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 5. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 - 6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 7. Compression Test Specimens: ASTM C 31.
 - a. Cast and laboratory cure two sets of three standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of three standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results shall be reported in writing to Owner's representative, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner's representative but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Owner's representative. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Owner's representative.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate that they do not comply with the Contract Documents. The corrections and any other work affected by or resulting from corrections to the concrete work shall be at the Contractor's expense.

SECTION 32160 – CONCRETE CURBS AND GUTTERS**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Machine-placed concrete curbs and integral gutters.
- B. Cast in place concrete curbs

1.1 RELATED SECTIONS

- A. Division 31 - Earthwork
- B. Section 03300 - Cast in Place Concrete

1.2 REFERENCES

- A. Comply with the provisions of local requirements, specifications, and minimum standards.

1.3 SUBMITTALS

- A. Submit the following if requested by Owner in accordance with General Requirements:
 - 1. Mix Design: Concrete mix design, including report on design strength test.
 - 2. Test reports on placed concrete:
 - a. Tests of materials, or review of test reports available from suppliers.
 - b. Field tests as specified herein.

1.4 QUALITY ASSURANCE

- A. Curbs on public property shall comply with all laws, rules and regulations of governmental authorities having jurisdiction over such work.

PART 2 PRODUCTS**2.0 MATERIALS**

- A. Portland Cement: ASTM C150, Type I, normal Portland cement; uniform gray color, from a single source.
- B. Aggregates: All fine and coarse aggregate shall conform to ASTM C33.
 - 1. Fine Aggregates: Natural or artificial, hard clean sand.
 - 2. Coarse Aggregates: Crushed stone, size 57.
- C. Water: Potable.
- D. Air Entraining Admixture: ASTM C260, "Air Mix" (The Euclid Chemical Co.); "MB-VR" or "Micro Air" (Master Builders); "Darex" (W.R. Grace & Co.); "Sika AER" (Sika Chemical Corp.); add only to normal portland cement concrete to meet requirements specified for air content.
- E. Liquid Membrane Curing and Sealing Compound: ASTM C309, Type 1, acrylic based, 18 percent minimum solids for use on vertical and horizontal surfaces, guaranteed not to affect bond on applied finishes, "Clear Bond" (Guardian Chemical Co., 708 Jefferson St., Atlanta, GA); Master Builder "Kore N Seal 800", "MB-429".
- F. Preformed Asphaltic Fiber Joint Filler: ASTM D1751, "Fiber Expansion Joint Filler, Code 1390" (W.R. Grace & Co.), non-extruding, for expansion joints which are to be sealed.

- G. Joint Sealer: Hot poured rubber asphalt type, "Papa-Plastic" (W.R. Grace & Co.); "HiSpec" (W. R. Meadows, Inc.); or approved substitution.

2.1 PROPORTIONING AND MIXING

- A. The testing laboratory shall design the mix for the concrete to obtain a strength, as determined by test cylinders, at least 15% higher than specified.
- C. The testing laboratory shall submit the copies of the mix design and the test results to the Owner.
- D. Cement content shall meet the design strength of 4,000 psi.
- E. Ready-Mixed Concrete shall conform with ASTM C94.
- F. The mixture shall contain no more water than is necessary to produce concrete which is workable and plastic within the limits specified herein for slump. The amount of water and proportion of mortar to coarse aggregate shall be the least which will produce uniformly dense concrete, free from aggregate pockets or honeycomb. Corrections shall be made for the amount of moisture contained in the aggregates and allowances shall be made for absorption of moisture by the aggregates during the period of mixing and handling. A uniform consistency shall be maintained continuously. Mixture shall contain 5-7% air entrainment. NO CALCIUM CHLORIDE shall be used. No water is to be added to the mix at the job site without approval from Owner's Representative.
- G. The consistency shall be determined by the method specified in ASTM C143.
- H. In general the slump shall be not less than 3" nor more than 5" for concrete which is not compacted by vibration; and not less than 2" or more than 4" for concrete which is compacted by vibration. In each of the above cases, slumps outside of the limits named may be used when satisfactory workability cannot be obtained within such limits and the slump is approved by the Owner's Representative.

PART 3 EXECUTION

3.0 PREPARING SUBGRADE

- A. Prior to fine grading, the rough grade shall be tamped or rolled until thoroughly compacted and shall be constructed true to grade and cross section.
- B. Fine grading and filling shall be performed using sand, or other granular subbase, uniformly graded. Subgrade shall be tested with an approved template. High spots shall be lowered and low spots raised. Subbase shall be compacted and leveled to grade.
- C. Wet the prepared subgrade to ensure a moist condition when concrete is placed.

3.1 MACHINE PLACED AND NON-REINFORCED CONCRETE CURBS

- A. Place and form concrete to the required shape with an approved type of extrusion machine. The face of the finished curb shall be true and straight, and the top surface of curbs shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge 10 feet long is laid on the top or face of the curb, the surface shall not vary more than 1/4" from the edge of the straightedge, except at grade changes or curves. All visible surfaces and edges of the finished curb shall be free of all blemishes and tool marks and shall be uniform in color, shape and appearance.
- B. Expansion joints and contraction joints shall be provided in all curbs, and shall be constructed at right angles to the line of curb, as specified herein and as shown.

1. Contraction joints shall be formed in the wet concrete by cutting a groove 2" in depth in all exposed surfaces using an approved cutting tool have a blade 1/8" wide. Provide contraction joints every 10 feet.
2. Expansion joints shall be formed by means of the specified type performed filler material 1/2" thick, cut and shaped to the cross-section of the curb. Expansion joints shall be provided in curbs at the ends of all returns, changes in directions and directly opposite the expansion joints of abutting concrete pavement, and unless otherwise shown shall be of the same thickness as the joints in the pavement. Provide expansion joints not to exceed 50 feet o.c.

3.2 CAST-IN-PLACE REINFORCED CONCRETE CURBS

- A. Provide control joints at 25 feet and expansion joints at 75 feet.

3.3 PLACING CONCRETE DURING HOT AND COLD WEATHER

- A. During cold weather, equipment and materials shall be provided to maintain a temperature of at least 50 degrees F. in the freshly placed concrete during the curing period. No frozen materials or materials containing snow or ice shall be used in the mix. No dependence shall be placed on salt or other chemicals for the prevention of freezing. No concrete shall be place on frozen subgrade.
- B. During hot weather, suitable precautions shall be taken to avoid drying of the concrete prior to finishing. Windbreaks, sunshades, covering, fog sprays, etc. shall be used as required, or directed by the Owner. Concrete deposited in hot weather shall have a placing temperature not greater than 80 degrees F., and shall be maintained at a temperature not greater than 90 degrees F during the curing period.

SECTION 32165 – SEGMENTAL CONCRETE RETAINING WALL**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.1 SECTION INCLUDES

- A. Segmental concrete retaining wall.
- B. Related materials required for construction of wall.

1.2 RELATED SECTIONS

- A. Division 31 - Earthwork

1.3 SUBMITTALS

- A. Submit the following if requested by Owner:
 - 1. Manufacturer's information of specified product.
 - 2. Test certificates verifying the following:
 - a. Load Bearing (ASTM - C90)
 - b. Testing of concrete masonry (ASTM - C140)

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall check the materials, upon delivery, to assure the proper material has been received.
- B. Special care shall be taken in the handling of units from coming in contact with mud, cement, etc.

PART 2 PRODUCTS**2.0 SEGMENTAL CONCRETE RETAINING WALL UNITS**

- A. Segmental concrete units shall conform to the following requirements:
 - 1. Face finish - sculptured rockface, striated, or as specified by the owner.
 - 2. Compressive strength at least 3000 psi.
 - 3. Adsorption not to exceed 6%.
 - 4. Shear strength between vertically adjacent units at least 1,500 plf minimum at normal pressure of 2 psi and greater.
 - 5. Exterior dimensions may vary in accordance with ASTM C90-85. Standard units shall have a minimum of 1 square foot area each.
 - 6. Units shall be interlocked and provide a built-in setback of 1:8.

2.1 SHEAR CONNECTORS

- A. Strength of shear connectors between vertical adjacent units shall be applicable over a design temperature of -10 degrees Fahrenheit to +100 degrees Fahrenheit.

2.2 BASE LEVELING PAD MATERIAL

- A. Material shall consist of compacted angular sand, gravel, crushed rock or leveling concrete (non-reinforced).

2.3 UNIT FILL

- A. Fill for units shall be free draining crushed stone or coarse gravel, 3/8-inch to 3/4-inch, with no more than 5 percent passing the No. 200 sieve.
- B. Place recommended fill behind the retaining wall units a minimum of six inches.

2.4 BACKFILL

- A. Material shall be site excavated soils or as per project drawings. Unsuitable soils for backfill (heavy clays or organic soils) shall not be used in the backfill.

PART 3 EXECUTION**3.0 EXCAVATION**

- A. Contractor shall excavate to the lines and grades shown on the drawings. Contractor shall be careful not to disturb embankment materials beyond lines shown.

3.1 BASE LEVELING PAD

- A. Leveling pad materials shall be placed as shown on the drawings, upon approved foundation, to a minimum thickness of 6 inches.
- B. Material shall be compacted so as to provide a level surface on which to place the first course of units. Compaction shall be to 95 percent of Standard Proctor for sand or gravel type materials. For crushed rock material shall be densely compacted.
- C. Leveling pad may be eliminated for walls less than 3 feet in height if existing site soils are inorganic, well draining, and naturally compacted.
- D. Contractor may opt for using reduced depth of sands, gravel or crushed rock using a concrete topping. Concrete shall be unreinforced and a maximum of 3 inches thick.

3.2 GEOGRID INSTALLATION

- A. When shown on the drawings or when the wall is of specific height whereby the unit manufacturer requires geogrid for tie-back support, geogrid shall be installed as per manufacturer's specifications.
- B. Geotextiles are recommended over cohesive soils, i.e. clays or silts. They are also a good choice over soils saturated for a large portion of the year.
- C. Utilize woven geotextile material.
- D. Overlap and cover the sides of the excavation. Create an overlap in the direction of the grade, much like shingles on a house. Begin by placing the fabric at the lowest elevation and working upslope.
- E. To prevent contamination of the base by soil at the sides of the excavation, cover the sides of the excavation with fabric and fasten it to the ground with metal staples while removing all wrinkles. Excess fabric and exposed staples can be removed once the job is completed.
- F. When a new section of fabric is placed it should overlap a minimum of 12 in. In weaker soils, it may be necessary to increase overlap to a minimum of 24 in. Consult manufacturer and/or soils engineer.

3.3 UNIT INSTALLATION

- A. First course of concrete wall units shall be placed on the base leveling pad. The units shall be checked for level and alignment.
- B. Ensure that units are in full contact with base.
- C. Units are placed side by side for full length of wall alignment. alignment may be done by means of a string line or offset from base line.
- D. Install fiberglass connecting pins and fill all voids at units with unit fill material.
- E. As appropriate where the wall changes elevation, units can be stepped with grade or turned into the embankment with a convex return end. Provide appropriate buried units on compacted leveling pad in area of convex return end.

3.4 CAP INSTALLATION

- A. Place cap units over projecting pins from units below.
- B. As required, provide permanent mechanical connection to wall units with construction adhesive. Apply adhesive to top surface of unit below and place cap unit into position.

3.5 BACKFILL PLACEMENT

- A. Unit fill shall be used for backfill adjacent to wall. Backfill shall be placed and compacted in lifts not to exceed 8 inches.
- B. Compaction requirements shall conform to Division 31 - Earthwork.
- C. At the end of each day's operation, the Contractor shall slope the last lift of backfill away from the wall units to direct runoff away from wall face.
- D. Only lightweight hand-operated equipment shall be allowed within 3 feet from the front face of the segmental concrete unit.

SECTION 32312 – FENCES AND GATES**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Fences around trash enclosure and mechanical equipment.
- B. Decorative Fencing
- C. Security Fencing

1.1 RELATED SECTIONS

- A. Section 05500 - Metal Fabrications
- B. Section 06100 - Rough Carpentry
- C. Section 09900 - Painting

1.2 PROJECT CONDITIONS

- A. Do not install wood fencing until all site work, concrete work, and sodding are complete. The site should be relatively dry. Coordinate all work with the general contractor.

1.3 QUALITY ASSURANCE

- A. All work shall meet the requirements of all government codes, regulations and safety directives related to the work.

PART 2 PRODUCTS**2.0 MATERIALS FOR WOOD FENCES**

- A. All wood shall be either:
 - 1. Western Red Cedar (No. #1 or clear)
 - 2. Redwood (Basket weave fences)
 - 3. Treated Souther Yellow Pine - Yellawood
- B. All posts used in the construction of this fence shall be rough sawn 4" x 4" treated Souther Yellow Pine or as shown on the drawings.
- C. All framework (stringers) used in the construction of this fence shall be dimensional 2" x 4" per the following:
 - 1. 6' height or less, 2 stringers 6" or less from the top or bottom.
 - 2. 8' height or less, 3 stringers 6" or less from the to or bottom.
- D. All fence boards (pickets) shall be 1" x 6" nominal rough sawn lumber with height of pickets as shown on the drawings. Unless otherwise stated on the drawings, all pickets shall have clipped corners (dog-ear).
- E. Gate hardware, heavy duty as required, shall be black powder coated fittings as manufactured by American Hardware, Tulsa, Oklahoma, or approved equal.
- F. Gate posts shall be a minimum 6" diameter schedule 40 steel and concrete filled. Each post shall be equipped with a grease fitting for smooth operation of collared hinges.
- G. Framework for the gates shall be 2"x2"x3/16" steel angle with "X" bracing as indicated on the drawings.
- F. All nails and/or staples used in the construction of this fence shall be galvanized or aluminized. If galvanized nails are used to secure the pickets to the stringers, nails shall be 2" ring-shank nails. A metal bracket, such as Simpson "Strong-Tie" #A23 or equal, and a 16 penny common nail shall be used to attach the stringers to the posts.

2.1 MATERIALS FOR CHAIN LINK FENCES

- A. Fence shall be 7' high above grade, using 6' high chain link fabric.
- B. Chain link fabric shall be either aluminum coated conforming to ASTM-A491 or zinc coated conforming to ASTM-A392 Class 2. Fabric shall be woven from 9 gauge (coated size) with in 2" mech. Fabric 72" high and over shall be knuckled at each selvage.
- C. Line posts shall be 2-3/8" O. D. standard weight galvanized pipe with minimum bending strength of 210 pounds under a 6' cantilever load coated with 2.90 ounces of hot dipped zinc in accordance with ASTM-F1083.8.
- D. Top and brace rails shall be 1-5/8" O. D. standard weight galvanized pipe with minimum vertical bending strength of 202 pounds on 10' span coated with 2.0 ounces of hot dipped zinc in accordance with ASTM-F0183 (formerly ASTM-A120. A 3/8" diameter galvanized tress rod and fittings shall be installed diagonally between end, corner or pull post to line post. One end of the truss rod attachment to end, corner or pull post shall be approximately 1" above grade and the other end attached approximately 1' below top of line post. Top rail couplings 6" minimum in length shall be spaced at maximum 21' centers. Fabric tie wire shall be spaced at 24" maximum centers.
- E. All end, corner and pull posts shall be 2 7/8" O.D. galvanized standard weight pipe with minimum bending strength of 381 pounds on 6' cantilever load coated with 2.0 ounces of hot dipped zinc in accordance with ASTM-F0183 (Formerly ASTM-A120). Gate posts shall be of the following sizes for single swing gates or one leaf of double gates:

Leaf Width	Gate Post	Lbs/Lin. Ft.
Up to 6'	2-7/8" O.D. Pipe Sch. 40 Galv.	5.79
Over 6' to 13'	4" O.D. Pipe Sch. 40 Galv.	9.11
Over 13' to 18'	6-5/8" O.D. Pipe Sch. 40 Galv.	18.97
Over 18'	8-5/8" O.D. Pipe Sch. 40 Galv.	28.55

- F. Gate Frames shall be tubular shaped, 1.90" outside diameter with welded or steel fitted corners. Braces and trusses shall be furnished when necessary.
- G. All fittings shall be pressed steel or malleable iron and shall be hot dip galvanized conforming to ASTM-A152. The wires shall be minimum 9 gauge aluminum or 11 gauge galvanized steel.
- H. All material is subject to testing. Mill certificates shall be submitted upon request of owner.

PART 3 EXECUTION

3.0 INSTALLATION

- A. All posts shall be spaced at 8' on centers unless slope of line dictates otherwise, but then no more than 10' on centers.
- B. All posts shall be set in ready-mix concrete. Holes shall be a minimum of one foot in diameter or as shown on the drawings and to a depth below the minimum frost depth no less than 30 inches. All posts shall be embedded in concrete and crowned gently to shed water. The annular space in gate posts shall be filled with concrete.
- C. All framework shall be fastened to the posts using metal brackets.
 - 1. Pickets shall be secured to the stringer using one nail for every 2" of picket width.
 - 2. Board-on-board vertical fences shall be "shadow box" design with the spacing no more than 3 inches between boards.
 - 3. Basket weave fences shall have a minimum height of four feet.

3.1 CLEAN UP

- A. All soil removed from the holes shall be disposed of off site or in an area approved by the Owner's Representative.
- B. The removal of all scraps of lumber from the site shall be the responsibility of the fence contractor.

SECTION 32930 - LANDSCAPING**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. The General Requirements of these specifications apply to all landscape operations.

1.1 DESCRIPTION

- A. Provide trees, plants, and ground covers as shown and specified. The work includes:
1. Soil preparation.
 2. Trees, plants, and ground covers.
 3. Planting mixes.
 4. Mulch and planting accessories.
 5. Existing plant relocation.
- B. Related work:
1. Division 31: Earthwork.

1.2 QUALITY ASSURANCE

- A. Comply with all applicable local, state and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.
- B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.
- C. The General Contractor's project manager shall oversee the work and assure its adherence to the plans and these specifications. Henceforth, this person shall be designated as Owner's Representative.
- D. Plant names indicated, should comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Provide stock true to botanical name. Do not substitute without permission of Owner or Owners Representative.
- E. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock." A plant shall be dimensioned as it stands in its natural position.
1. For plant material grown in fabric-ground containers, the following chart shall determine root mass size in relation to caliper:
Fabric-ground Suggested Container Diameter Caliper of Size Plant
10" / 1"
12" / 1"
14" - 16" / 1 1/2" - 2"
18" - 20" / 2" - 3"
22" - 24" / 3" - 4"
- F. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project.
- G. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost to owner. Root systems must meet AAN standards as specified. Plants should not be altered by pruning or other means to meet specifications.
- H. Provide "specimen" plants with a special height, shape or character of growth. Specimen trees or shrubs may be tagged at the source of supply. The Owner's Representative may inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.
- I. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size and variety.

1.3 SUBMITTALS

- A. Submit the following material samples, if requested by Owner:
 - 1. Mulch -Bulk or Bagged.
 - 2. Decorative Stone or Gravel -Bag or Bulk
- B. Submit the following materials certification, if requested by Owner:
 - 1. Topsoil source and pH value.
 - 2. Peat moss, compost, or other organic soil amendments
 - 3. Plant fertilizer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer materials in original, unopened and undamaged containers showing weight, analysis, and name of manufacturer. Store all materials in a manner to prevent moisture and deterioration.
- B. Take all precautions customary in good nursery practice to prepare plants for transport. Workmanship, which fails to meet the highest standards, will be rejected. Spray deciduous plants in foliage with an approved Anti-Desiccant immediately before digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury.
- C. Cover plants transported on open vehicles with a protective covering to prevent windburn.
- D. Deliver plant materials properly labeled for identification and store in shade protected from weather.
- E. Time delivery of sod so that placement occurs within 24 hours after stripping. Protect against drying and breaking of rolled strips.
- F. Plant material shall be planted immediately upon delivery. No plant shall be bound with rope or wire in a manner that would damage the bark or break the branches.

1.5 PROJECT CONDITIONS

- A. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Contact utility companies before digging. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.
- B. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the applicable utility company immediately to obtain procedure directions. Cooperate with the applicable utility company in maintaining active services in operation.
- C. Locate, protect, and maintain benchmarks, monuments, control points and project engineering reference points. Re-establish disturbed or destroyed items at Contractor's expense.
- D. Obtain governing authorities written permission when required to close or obstruct street, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.
- E. Control dust caused by the work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.
- F. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by work operations. Cost of repair and restoration of damaged items at Contractor's expense.
- G. Protect and maintain streetlights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mailboxes with the applicable governmental agency.
- H. Work notification: Notify Owner's Representative at least five (5) working days prior to installation of plant material.

- I. Protect existing improvements, paving, utilities and other facilities from damage caused by landscaping operations.
- J. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings.

1.6 WARRANTY

- A. Warrant plant material and lawns to remain alive and be in a healthy, vigorous condition for a period of one (1) year after acceptance, provided plants are given proper care during this period.
 - 1. Contractor to call for final inspection of plants.
- B. Remove and immediately replace all plants, as determined by the Owner's Representative, to be unsatisfactory during the initial planting installation.
- C. Replace all plants that are dead or, as determined by Owner's Representative, are in a severely unhealthy condition within warranty period. Replacement plants shall be installed at next best planting season.
- D. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, drought, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting areas; acts of vandalism or negligence on the part of the Owner. Any replacement attributed to these causes must be in addition to the contract amount.

PART 2 PRODUCTS

2.0 PLANT MATERIALS

- A. Plant Materials: Plant materials shall conform to the type and size indicated on the Drawings and shall be sound, healthy, vigorous, and free from plant diseases and insect pests and their eggs, and shall have normal, healthy root systems. Measurements, such as spread, ball size, number of canes, quality designations, etc., shall be in accordance with the latest edition of "American Standards for Nursery Stock."
 - 1. Substitutions will not be permitted without prior approval by Owner.
 - 2. Plants designated "BB" in the Plant List shall be balled and burlapped. They shall be dug with firm natural balls of earth of sufficient depth and radius to encompass the fibrous and feeding root systems necessary for the full recovery of the plant. Balls shall be securely wrapped with burlap and bound with cord. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock." Cracked or mushroomed balls are not acceptable.
 - 3. Container-grown stock shall have grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.
 - a. No plants shall be loose in the container.
 - b. Container stock shall not be pot bound.
 - 4. If the use of larger than specified plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.
 - 5. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size and variety designated in the plant list and according to the AAN Standards for Nursery Stock.
 - 6. Shrubs and small plants shall meet the requirements for spread and/or height indicated in the plant list and be in accordance with AAN standards.
- B. Commercial Fertilizer: Shall be uniform in composition, free flowing and suitable for application specified, and containing nitrogen, phosphorous, and potassium in percentages by weight indicated in this Specification and plan notes.
- C. Weed Killer: Type recommended by State Agriculture Department.
- D. Planting Mixture: The material which is used for tamping around the balls and roots in the process of planting shall be a soil mixture as indicated on the Drawings.
- E. Mulch:

1. Wood Chip Mulch: Shredded hardwood bark.
2. Gravel Mulch: 3/4 inch crushed buff color limestone rock as noted in the plan notes.
- F. Edging (if applicable): Valley View 'Black Diamond' edging. Install per manufacturer's specifications.
- G. Topsoil: Friable clay loam surface soil found in a depth of not less than 4", free of or reasonably free of subsoil clay lumps stones and other objects over 2" in diameter, and without weeds, roots and other extraneous and toxic matter harmful to plant growth.
 1. Topsoil has been (or will be) stockpiled for re-use in landscape work. If quantity of stockpiled topsoil is insufficient, provide additional topsoil as required to complete landscape work.
 2. Topsoil for landscape work is not available at site and must be furnished as specified.
 3. Obtain topsoil from local sources or from areas having similar soil characteristics to that found at Project site. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4"; do not obtain from bogs or marshes.

2.1 LAWN MATERIALS

- A. Sod: Sod shall be mixed Kentucky Bluegrass or a Tall Turf-Type fescue common to the locality, free of pernicious weeds and conforming with Local/State Specifications. Weed content shall not be over 0.30 of 1 percent. It shall be mowed to a height of not less than 1 1/2" before lifting and shall be of uniform thickness with not less than 1" of soil.
 2. Cellion fiber mulch or equal.
- B. Fertilizer:
 1. Granular, non-burning product composed of not less than 50% organic, slow acting, guaranteed analysis professional fertilizer.
 2. Starter fertilizer containing 10% nitrogen, 10% phosphoric acid, and 10% potash by weight, or similar approved composition.

2.2 ACCESSORIES

- A. Water: Hoses or other methods of transportation furnished by Contractor. Note: Contractor may need to truck water to site if not yet available.
- B. Stakes for staking: Hardwood, 2" x 2" (6-8') long (2x4 pine is permissible).
- C. Stakes for guying: Hardwood, 2" x 2" x 24" long.
- D. Guying/staking wire: 12- or 14-gauge galvanized wire.
 1. Turnbuckles: Galvanized steel of size and gauge required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".
- E. Staking and guying hose: Two-ply, reinforced garden hose not less than 1/2" inside diameter. Shall be uniform in color.
- F. Plastic guy material no less than 1/4". Shall be uniform in color and level as applied.
- G. Twine: Two-ply jute material.
- H. Weed control barrier: Rot resistant polypropylene fabric or equivalent, water and air permeable.

PART 3 EXECUTION

3.0 EXAMINATION

- A. Examine the soils, surrounding construction and the conditions under which landscaping work is to be performed, and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Time of planting:
 - 1. Evergreen material: Plant evergreen materials between September 1 and December 1 or in spring before new growth begins. If Owner requires planting at other times, plants shall be sprayed with anti-desiccant prior to digging operations, weather dependent.
 - 2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in- leaf, they shall be sprayed with an anti-desiccant prior to digging operation.
- B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.
- C. Locate plants as indicated on drawings. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until Owner's Representative has selected alternate plant locations.
- D. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least twice as wide as the root system and 24" greater for trees. Depth of pit shall be no greater than the root ball depth. Scarify bottom of the pit. Remove excess excavated materials from the site.
- E. Provide pre-mixed ground cover bed planting mixture for use around the balls and roots of the plants consisting of five (5) parts existing soil to one (1) part peat moss and 1lb. plant fertilizer for each cubic yard of mixture or equivalent. Bagged bark professional mixes are an equivalent substitute for peat moss.
- F. Provide pre-mixed ground cover bed planting mixture consisting of three (3) parts existing soil to one (1) part peat moss and 1lb. plant fertilizer per cubic yard. Provide beds a minimum of 6" deep. Bagged bark professional mixes are an equivalent substitute for peat moss.
- G. Loosen topsoil of lawn areas to minimum depth of 3", if compacted. Remove stones over 1" in any dimension, sticks, roots, rubbish, and extraneous matter.
- H. Apply lime to lawn areas at a rate to adjust pH of topsoil to not less than 5.5 nor more than 6.8. Distributed evenly by machine and incorporate thoroughly into topsoil.
- I. Apply fertilizer to indicated turf areas at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs./acre).
- J. Grade lawn areas to a smooth, free-draining, even surface with a loose, moderately coarse texture.
- K. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to sodding.

3.2 PRE-PLANTING

- A. Pre-planting.
 - 1. Plants shall be brought to the site the day they are to be installed, if possible. If situations arise where earlier delivery can't be avoided or if planting is delayed after the plants have been delivered, they shall be stored where they can be properly watered, sheltered from direct sunlight, and protected from mechanical damage by construction equipment, animals, etc. If storage needs to be more than two days, the plants shall be separated far enough from each other to provide good air circulation to their tops, reducing the risk of fungus. Bare root plants which must be held shall be healed-in where they can be watered as needed.
 - 2. All plants shall be watered thoroughly and allowed to drain prior to planting.
 - 3. While planting, bare root plants must be protected from hot sun and drying wind by shading them with burlap, landscape fabric, straw or other breathable material. Plastic is unacceptable. Containerized plants must be left in their containers until each is planted. They shall not be removed from the containers to be laid out on the bed where sun and wind will damage the roots prior to planting.
 - 4. Any dead or damaged plant parts shall be removed from the plants upon planting.

- B. Mulching is an option which may be specified for artistic reasons, water conservation, weed control or erosion control. Where mulching is specified, the mulch must be pulled away from the stems and crowns of herbaceous perennials to reduce the occurrence of rot or rodent damage. Mulch thickness should be 2 inches or less.

1. Weed control barrier: Install filter fabric prior to Mulch beds.

3.3 FINISH GRADING

- A. Over subgrade in lawn areas place topsoil to a minimum depth of 4". Topsoil shall be free from gravel, rocks, weeds, roots, etc. No mulch and black sand shall be used.
- B. Spread topsoil evenly over lawn areas to be sodded. The finish surface shall be smooth and true to contours as indicated. Bring to elevation as required to allow installation of sod. Grades shall slope away from building at all points.
- C. Topsoil shall not be placed when the sub-grade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to planting and proper grading.

3.4 SODDING

- A. Fine rake topsoil to break up lumps and to remove foreign material.
- B. 10-10-10 fertilizer shall be spread evenly with a mechanical spreader at the rate of 20 lbs. per 1000 s.f. and thoroughly incorporated into the topsoil to a depth of 2". The surface shall then be re-compacted.
- C. Inequities and soft spots shall be corrected before the sod is laid. Sod shall be laid solidly with joints staggered so that no voids occur between the strips. Weeded roots, if any, must be removed before the sod is laid. Sod shall be tamped or rolled immediately after it is laid, and the finished surface shall be true to grade, and shall be smooth, even and equally firm at all points.
- D. Sodded areas shall be kept moist for the maintenance period. After the sod is installed, areas which fail to show a uniform stand of grass shall be re-sodded.

3.5 PLANTING

- A. Pits for trees and shrubs shall be excavated as part of this work. Subsoil dug from pits, trenches and beds shall be disposed of by the Subcontractor.
- B. The Subcontractor is responsible for planting to correct grades and alignment and plants shall be set so that, when settled, they will bear the same relation to finish grade as they did before being transplanted. No filling will be permitted around trunks and stems. Cut and remove wire baskets from roof balls upon final placement of trees.
- C. Plant pits shall be thoroughly soaked before planting. When the plant has been properly set, the pit shall be backfilled with planting mixture, gradually filling, tamping and settling with water. No soil in a frozen or muddy condition shall be used for backfilling. A ring of soil shall be formed around the edge of each plant to hold water. After each watering beds shall be raked and left in complete and finished manner.
- D. Planting shall be mulched with a cover of mulch.
 1. Install approved filter fabric directly below mulched plant beds, lapping edges and ends 3" minimum, allowing no gaps in coverage.
 2. Install 4 inch depth mulch under all trees, shrubs, and ground cover massings unless otherwise shown on Drawings.
- E. Upon completion of planting, trees and shrubs shall have been pruned and injuries repaired. The amount of pruning shall be limited to the minimum necessary to remove dead and injured twigs and branches and to compensate for the loss of roots from transplanting. Pruning shall be done in such a manner as not to change the natural habit and shape of the plant. Cuts shall be made flush leaving no stubs.
- F. Guying and staking is optional. (Guying trees 3" and over in caliper and stake trees under 3" in caliper. Maintain guys and stakes until the end of the guarantee period.) The

trunks of deciduous trees shall be wrapped with standard tree wrap from the ground up to the first branch with 50 percent overlap.

- G. If shown on drawings, install Valley View edging to contain shrub massing where planting beds meet sod.

3.6 ADJUSTING

- A. Inspection of the planting will be made jointly by the Subcontractor and Owner's Representative at the completion of planting. Plants which are not in a healthy, growing condition shall be removed and replaced with plants of like kind, size and quality as originally specified before the close of the next planting season.
 - 1. Replace dead and dying plants with original plant and planting mixture during guarantee period at no cost to Owner.
 - a. Replacement plants shall be warranted and maintained for an additional period of 1 (one) year. Warranty is limited to 1 (one) replacement per plant. Replacement stock shall meet Specifications and quality of original stock.
 - 2. Repair damage to lawns and other plants during replacement at no cost to Owner.
- B. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
- C. Tighten and repair guy wires and stakes as required
- D. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
- E. Water trees, plants and ground cover beds prior to acceptance by Owner.
- F. The beds should be checked regularly for soil settling which may expose the root balls or otherwise endanger the health of the planting. Should this occur, the contractor shall correct the settled areas
- G. Should insects or diseases attack the plants after installation and prior to acceptance of the planting, appropriate pesticides shall be properly applied.
- H. Recondition existing lawn areas damaged by Contractor's operations, including storage of materials or equipment and movement of construction vehicles, and existing lawn areas as indicated.
- I. Provide fertilizer, seed and soil amendments as specified for new lawns and as required to provide a satisfactorily reconditioned lawn. Provide topsoil as required to fill low areas and meet new finished grades.
- J. Remove diseased or unsatisfactory lawn areas. Do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, stone, gravel, and other construction materials.
- K. Thin lawn areas shall be cultivated and re-seeded.

3.7 MAINTENANCE

- A. Plantings and turf areas shall be maintained by this Subcontractor for a period of 30 days after acceptance. Maintenance shall include necessary watering, weeding, mowing and spraying, to assure healthy vigorous growth.

3.8 PROTECTION OF WORK

- A. Occupancy of the Project shall not relieve the Subcontractor of any of the obligations outlined in these Specifications.
- B. Landscaped areas shall be protected by the Subcontractor against traffic damage, erosion, or other use by erecting barricades or temporary fencing immediately after planting is completed. These barricades, or temporary fencing, and signs shall be maintained until the lawns are well established.
- C. Upon final acceptance of the Work specified herein the Subcontractor shall remove barricades or temporary fences, unless otherwise directed.

- D. At the end of the warranty period, the Subcontractor shall remove guying, staking, wrapping, and saucers from the site.

3.9 ACCEPTANCE

- A. Planted areas will be inspected at completion of installation and accepted subject to compliance with specified materials and installation requirements.
 - 1. Planted areas will be accepted provided all requirements have been complied with and plant materials and lawn areas are alive and in a healthy, vigorous condition.
- B. The beds shall be free of weeds at planting time and shall be maintained weed free by the contractor until the planting is accepted by the client.

3.10 CLEANING

- A. Perform cleaning during installation and upon completion of the work. Remove from site all excess materials, soil, debris, and equipment. Repair damage resulting from planting, or sod.
- B. Pressure wash driveways, sidewalks, curbs, etc. free of all dirt and residue.

SECTION 32950: IRRIGATION SYSTEMS**PART 1 GENERAL****1.0 SECTION INCLUDES**

- A. Design and complete underground sprinkler system as specified herein.
- B. Furnish and install piping and fittings, valves, quick coupling valves, sprinkler heads, controllers and all miscellaneous fittings, accessories, and all equipment needed.
- C. Maintenance Service: Irrigation Subcontractor shall provide the following services after the installation and acceptance by the Owner:
 - 1. Perform 1 (one) Fall system winterization.
 - 2. Perform 1 (one) Spring system start-up.
 - 3. Work required within the one year corrective period from the date of acceptance letter or notice by the Owner, shall be the irrigation system subcontractors responsibility.

1.1 RELATED SECTIONS

- A. Section 32900 - Landscaping
- B. Division 22 - Plumbing
- C. Division 26 - Electrical

1.2 SUBMITTALS

- A. Submit the following in accordance with General Requirements:
 - 1. Manufacturer's Literature: Materials description, installation, operating and maintenance instructions.
 - 2. Shop Drawings: Complete system design with each component identified.

1.3 QUALITY ASSURANCE

- A. All work shall be installed according to applicable codes and ordinances of the city and National Electrical Code. Permits required shall be obtained and paid for by the Irrigation Subcontractor.
- B. The work of this section shall be done by a firm regularly engaged in, and specializing in this work, with a minimum of 5 years experience in the type of work shown and specified.
- C. Entire irrigation system shall be coordinated with the Landscape Subcontractor.

PART 2 PRODUCTS**2.0 ACCEPTABLE MANUFACTURERS**

- A. Rain Bird Sprinkler Mfg. Corp.
- B. Toro Company

PART 3 EXECUTION**3.0 EXAMINATION**

- A. Examine the areas and conditions under which underground sprinkler system is to be installed and notify Contractor, in writing, of conditions detrimental to the proper and

timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. The Irrigation Subcontractor is responsible for locating underground obstacles. It is not represented that the Drawings show all sewers, water lines, gas lines, telephone lines and other underground obstacles. Exercise caution to prevent damage to existing facilities during the progress of the construction work, taking care to locate same, where possible, in advance of the actual work. The Irrigation Subcontractor shall make good all damage to existing utilities resulting from his operations.

3.2 SERVICE

- A. Plumbing Subcontractor shall provide:
 - 1. Appropriate size Type K copper line (stub out) to 6 " outside of the building. Coordinate location with Irrigation Subcontractor.
 - 2. Separate meter and vacuum breaker or a deduct meter if acceptable to utility company.
 - 3. 120 Volt electrical current shall be provided to a junction box adjacent to the controller by the Electrical Subcontractor.

3.3 EXCAVATION AND BACKFILL

- A. All pipe lines shall be installed in the locations and of sizes indicated on the final Shop Drawings. Piping shall be laid accurately to line and grade.
- B. Install Class 200 PVC pipe sleeves under drives and sidewalks and extend 12" (minimum) beyond the edge of such construction.
 - 1. Coordinate irrigation sleeve installation with General Contractor.
 - 2. Sleeves shall be sized and placed appropriately to accommodate irrigation system piping.
- C. Interior of piping shall be kept clear of foreign matter before installation and shall be kept clean by means of plugging or capping ends after placement in trenches.
- D. Minimum depth of cover shall be at least 10" for the main and lateral lines.
- E. Provide 3/4" brass valve inside the building to winterize the system by the blowout method.

3.4 AUTOMATIC CONTROLLER

- A. Automatic controller shall be the type and model for the use intended and shall include at least the following features:
 - 1. 0-90 minute variable station timing.
 - 2. 14 day programmable.
 - 3. 24 hour clock.
 - 4. Automatic/manual switch.
 - 5. Rapid advance.
 - 6. Fuse protection.
- B. All 120 volt and control wires shall be placed in conduit. Arrangement of the controller and conduit shall be beneath in appearance and adjacent to the wall. All electrical wires shall be installed in accordance with city, state, and national codes.
- C. Number of stations to be determined by manufacturer.

3.5 CONTROL WIRE INSTALLATION

- A. All electric wire shall be installed in the pipe trenches whenever possible. Wire shall be placed underneath the pipe.
- B. Wire shall be bundled together every 20' with electrical tape. Expansion joints in the wire shall be provided by making a 12" loose coil.
- C. All control or hot wire shall be of one color (black) and all common or ground wire shall be of another color (white).
- D. Wire connections to control valves and splices shall be made using "Moistite" wire connectors and potting compound.
- E. All wire connections at control valves and splices shall be left with sufficient slack so that in case of repair the valve bonnet or splice may be brought to the surface without disconnecting the wires.

3.6 VALVES AND SPRINKLER HEADS

- A. The sprinkler heads shall be fixed spray or gear driven rotary. All sprinkler heads and quick coupling valves shall be set perpendicular to finish grades unless otherwise specified.
- B. Sprinkler heads adjacent to walls, curbs or other paved areas shall be set to grade.
- C. Install all new valves as may be required for the proper control of the piping systems in which they are incorporated.

3.7 VALVE BOX INSTALLATION

- A. All remote control valves or gate valves shall be installed in a valve box.
- B. All valve boxes shall be installed on a suitable base for proper foundation of box and easy leveling of box to proper grade. All valve boxes shall be provided with proper length and size extension to bring the valve box level with the finish grade and so the bottom of the valve box is a minimum of 2" below the bottom of the valve.
- C. The interior of the valve boxes shall be left free of dirt and debris and the entire length of the pipe and valve in the valve box shall be free and clean and level with the bottom of the valve box.
- D. If the holes where pipe enters the valve box are excessively large so that dirt will fall in around the pipe, plug the hole with leak proof material.
- E. Location of irrigation system heads, piping and valves shall be marked to avoid damage during completion of the landscaping work.

3.8 FIELD QUALITY CONTROL

- A. When the main line or sections of the main line, laterals, swing joints and valves have been installed, the system (or section) will be thoroughly flushed. The system (or section) will then be pressurized by means of a hydrostatic test at 120 psi. The test period shall be for 2 hours.

3.9 CLEANING AND FLUSHING SYSTEM

- A. After pipe, fittings, and valves have been installed and connections made to the water source, flush pipes several times until free from all rocks, dirt, trash, pipe shavings, or debris before installing heads. After the pipe has been thoroughly flushed start installing the heads with the water running, beginning with the one nearest the valve and working towards the ends of the laterals forcing the water

and any debris left in the pipe out the last head connection. After the heads have been installed, the system is to be used several times before final inspection. The heads shall be cleaned or replaced if necessary before final inspection.

3.10 ADJUSTING AND CLEANING

- A. The Irrigation Subcontractor shall make final cleanup of all parts of the work before final acceptance. This cleanup shall include removal of all construction materials and equipment, and in general preparing of the site in an orderly and finished appearance.
- B. Remove from the site, rock and extra dirt resulting from the performance of this work and restore the site to its appearance prior to beginning irrigation work.

3.11 SERVICES OF IRRIGATION SUBCONTRACTOR

- A. The Irrigation Subcontractor shall school at least 2 of the employees, who will be maintaining the irrigation system, in operating and maintaining the system. This will include the operation of the controllers and valves, how to most effectively use the system, maintenance on all equipment including removal and replacement of valve and controller components.

3.12 EXTRA PARTS AND PARTS LIST

- A. Provide 2 copies of the parts list and manufacturer's catalog showing performance, weight, quality and functions of each item of equipment installed.

SECTION 33310 – DRAINAGE PIPE AND FITTINGS FOR SEWERS**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Section 31000 - Earthwork
- B. Section 31231 – Rock Removal
- C. Section 33462 – Geotextile Subsurface Drainage Filtration
- D. Section 33391 – Manholes, Frames and Covers for Sewers
- E. Geotechnical Soils Report (if available)

1.2 SUMMARY

- A. The Contractor shall furnish all labor, material, and equipment necessary to install gravity sewer piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

1.02 SUBMITTALS

- A. Product Data (if requested by Owner): Manufacturer's data including dimensions and strength information.

PART 2 PRODUCTS**2.0 DUCTILE IRON PIPE AND FITTINGS**

- A. Ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151). The pipe shall be designed for an internal working pressure of 150 psi and external loading based on flat bottom trenches without blocks and untamped backfill laying conditions. The pipe shall conform to the following minimum thickness classes: pipe size 4 inches and smaller, Class 51; pipe size 6 inches and larger, Class 50.
- B. Fittings shall be Class 250 ductile iron fittings in accordance with ANSI A 21.10 (AWWA C 110).
- C. Joints shall be push-on type, mechanical joint type conforming to ANSI A21.11 (AWWA C 111) or restrained joint type. Unless specifically required at designated locations by the Drawings, the type of joint used is optional. Restrained joints shall be TR-Flex type as manufactured by U.S. Pipe and Foundry Co., or approved equal.
 - 1. Push on joints shall have an annular recess in the pipe socket to accommodate a single rubber gasket. Plain ends shall be suitably beveled to permit easy entry into the bell. The gasket and annular recess of the socket shall be so designed and shaped that the gasket is located in place against displacement as the joint is assembled.
 - 2. Mechanical joints shall be bolted and of the stuffing box type and shall consist of a bell with exterior flange and interior recess for the sealing gasket, a pipe or fitting plain end, a sealing gasket, a follower gland, tee-head bolts and hexagon nuts.
 - 3. Restrained joints for a 4" through 54" push-on joint pipe installation is required and indicated in the project plans or specifications, restrained push-on joint pipe and fittings utilizing ductile iron components shall be provided.
 - a. Restrained joint pipe shall be ductile iron manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51. Push-on joints for such pipe shall be in accordance with ANSI/AWWA C111/A21.11. Pipe thickness shall be designed in accordance with ANSI/AWWA C15-/A21.50, and shall be based on laying conditions and internal pressures as stated in the project plans and specifications. Pipe shall be U.S. Pipe TR FLEX pipe or equal.

- b. Restrained joint fittings shall be ductile iron in accordance with applicable requirements of ANSI/AWWA C110/A21.10 with the exception of the manufacturer's proprietary design dimensions. Push-on joints for such fittings shall be in accordance with ANSI/AWWA C111/A21.11. Fittings shall be U.S. Pipe TR FLEX fittings or equal.
- c. Cement mortar lining and seal coating for pipe and fittings, where applicable, shall be in accordance with ANSI/AWWA C104/A21.4. Bituminous outside coating shall be in accordance with ANSI/AWWA C151/A21.51 for pipe and ANSI/AWWA C110/A21.10 for fittings.
- d. Restrained push-on joints for pipe and fittings shall be designed for a water working pressure of 350 psi in sizes 4" through 24" and 250 psi for sizes 30" through 54".
- e. Restrained push-on joint pipe and fittings shall be capable of being deflected after assembly.
- 4. All ductile iron pipe and fittings shall have the manufacturer's outside coal tar or asphaltic base coating and a polyethylene lining complying with ANSI/ASTM D1248 on the inside.
- D. The inside lining material for pipe and fittings shall be virgin polyethylene complying with ANSI/ASTM D1248, compounded with an inert filler and with sufficient carbon black to resist ultra-violet rays during above ground storage of the pipe and fittings. The polyethylene shall be bonded to the interior of the pipe of fitting by heat.
 - 1. All surface areas to be lined shall be blast cleaned comparable to the requirements of SSPC-SP6 or NACE #3.
 - 2. Polyethylene linings shall cover the inner surface of pipe and fittings as shown and described below. In pipe utilizing push-on gaskets, the lining shall extend from the spigot end through the socket to the edge of the gasket sealing area. In mechanical joint pipe the lining shall extend from the spigot end through the socket to the edge of the gauging ring. The lining in fittings shall cover the interior surfaces including the socket areas as defined above.
 - 3. Lining in piping and in the fittings shall be 40 mils nominal thickness. Minimum lining thickness shall be 30 mils.
- E. Pipe shall be furnished in lengths of 16, 16.5, 18 and 20 feet nominal laying lengths. The weight of any single pipe shall not be less than the tabulated weight by more than 5 percent for pipe 12 inches or smaller in diameter, not by more than 4 percent for pipe larger than 12 inches in diameter.
- F. The net weight, class, or nominal thickness and sampling period shall be marked on each pipe. The pipe shall also be marked to show that it is ductile iron.

2.1 PIPE JOINTING FOR DUCTILE IRON PIPE

- A. Mechanical Joint:
 - 1. Mechanical joints are to be furnished according to AWWA Specifications C111. All pipe joints must be furnished complete with all accessories. Mechanical joint bolts and nuts shall be of alloy cast iron (such as Acipcoloy) or alloy steel (Corten type such as US alloy) or approved equal. Rubber gaskets shall be made of plain first grade rubber, free of imperfections and porosity. Hardness shall be 70 to 75 durometer.
 - 2. Mechanical joints shall be used where specifically called for on the Drawings.
 - 3. Push-in socket joints shall be equal to manufacturer's specifications for "Tyton," "Bell-Tite", or "Fastite".

The joints shall consist of a rubber ring gasket compressed in groove in bell of pipe with beveled pigot end of pipe for initial centering into rubber gasket in bell.
 - 4. All items used for jointing pipe shall be furnished with the pipe and tested before shipment. The joints shall be made with tools and lubricant in strict conformity with the manufacturer's instructions. If requested, three (3) copies of such instructions shall be delivered to the Engineer at start of construction.

2.2 POLYVINYL CHLORIDE (PVC) GRAVITY SEWER:

- A. Polyvinyl chloride (PVC) pipe and fittings, 4 to 15 inch in diameter, for gravity sewers shall conform to the requirements of ASTM specification D-3034 (SDR 35), current approval, "Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings."
- B. Polyvinyl chloride (PVC) pipe and fittings, 18 inch to 24 inch in diameter shall conform to the requirements of ASTM specification F679, current approval.
- C. Joints for PVC pipe shall be of the elastomeric gasket type and installed per the manufacturer's recommendations. Pipe that has been field cut must be beveled for insertion into gasketed joints. Bevel can be made with hand or power tool. In either case, the finished bevel should be the same as the factory bevel. All pipe shall be provided with home marks to insure proper gasket seating. Gasket material shall comply with the physical requirements specified in ASTM D-1869, C-361, C-433, current approval.
- D. Fittings for service connections shall be of the factory made inline type conforming with the requirements of ASTM specification D-3034, current approval. Saddle type fittings shall not be used.
- E. PVC sewer pipe shall be supplied in standard lengths of at least 12'6". Longer lengths are permitted.
- F. PVC sewer pipe shall be marked with the manufacturer's name, production lot number, ASTM designation, PVC, and the nominal diameter.
- G. All underground place piping shall have a metallic tape laid 2 feet above the pipe. The tape shall have the word "Caution" printed on it and shall identify the pipe use. Product shall be Seton Name Plate Corp., New Haven, Connecticut, No. 210, or equal.
- H. Five copies of directions for handling and installing shall be furnished the Contractor for the manufacturer at the first delivery of the pipe to the job.

2.3 PIPE JOINTING FOR PVC PIPE

- A. Polyethylene Pipe Joints: Jointing of polyethylene pipe shall be by the butt fusion method and shall be performed in strict conformance to the pipe manufacturer's recommendations using approved equipment. Fittings shall be connected with stainless steel couplings if fusion is not possible.
- B. Where used in highway crossing, the Contractor shall take precautions to insure no damage to the pipe when placing it in the casing

2.4 POLYVINYL CHLORIDE (PVC) FORCE MAIN:

- A. PVC pipe shall comply with ASTM D1784 and shall be Class 200 (SDR 21) as shown on the Drawings. All PVC pipe shall conform to the latest revisions of the following specifications:
 - 1. ASTM D2241 (PVC plastic pipe SDR-PR and Class T).
 - 2. Commercial Standard CS 256 (pressure rated type).
 - 3. National Sanitation Foundation Testing Laboratories (NSF).
- B. The name of the manufacturer of the plastic pipe to be used must be found on the current listing of Plastic Materials for Potable Water Application, published by the NSF (National Sanitation Foundation), Ann Arbor, Michigan, and must meet the requirements of the Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, D1784, published by ASTM (American Society for Testing and Materials). Rubber gasketing shall conform to ASTM 1869.
- C. Pipe lengths shall not exceed 40 feet. Wall thickness shall exceed 40 feet. Wall thickness shall be in accordance with CS-256 and ASTM D2241. Pipe ends shall be beveled to accept the gasketed coupling.
- D. Samples of pipe, physical and chemical data sheets shall be submitted to the Engineer for approval, and his approval shall be obtained before pipe is purchased.
- E. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practical in color.
- F. Pipe shall have a ring painted around spigot ends in such a manner as to allow field checking of setting depth of pipe in the socket.
- G. Pipe must be delivered to the job site by means which will adequately support it and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are

not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.

- H. The couplings and fittings shall be furnished by the pipe manufacturer and shall accommodate the pipe for which they are to be used. They shall have a minimum pressure rating of 200 psi (SDR 21). Insertion depth of the pipe in the coupling shall be controlled by an internal PVC mechanical stop in the coupling which will allow for a thermal expansion and contraction. Coupling method shall allow for half of the expansion or contraction of each pipe section to be taken up at each end of the pipe. Couplings shall permit 5 degree deflection (2 1/2 degree each side) of the pipe without any evidence of infiltration, exfiltration, cracking or breaking. Couplings shall have rubber seals factory installed.
- I. Pipe markings shall include the following, marked continuously down the length:
 - 1. Manufacturer's name.
 - 2. Nominal size.
 - 3. Class pressure rating.
 - 4. PVC 1120.
 - 5. NSF Logo.
 - 6. Identification Code.
- J. Lubricant shall be water soluble, non-toxic, be non-objectionable in taste and odor imparted to the fluid, non-supporting of bacteria growth, and have no deteriorating effect on the PVC or rubber gaskets.
- K. All underground plastic piping shall have a colored metallic tape laid 2 feet above the pipe. The tape shall have the words "caution" printed on it and shall identify the pipe use. Use Seton Name Plate Corp., New Haven, Connecticut, No. 210 or equal.

2.5 CONCRETE PIPE

- A. Reinforced Concrete Pipe: DOT Section 706-02, Class
- B. Furnish pipe of the strength given in the table below. Use standard strength pipe unless extra strength is indicated.

PIPE STRENGTH (Lbs/Lin Foot - ASTM Three-Edge Bearing Method)		
PIPE SIZE (INCHES)	STANDARD STRENGTH	EXTRA STRENGTH
4	1500	2000
6	1500	2400
8	1500	2400
10	1600	2400
12	1800	2600
15	2000	2900
18	2200	3300
21	2400	3850
24	2600	4400

2.6 BITUMINOUS COATED CORRUGATED STEEL PIPE

- A. Corrugated Steel Pipe, Round or Arch: Conform to DOT Section 707-02 except as herein amended.
 - 1. Coat uniformly with bituminous material inside and out with a minimum thickness of 0.05 inches. Apply additional bituminous material by centrifugal methods forming a smooth lining on the interior of the pipe, filling the corrugations and having a minimum thickness of 1/8 inch above the crest of the corrugations.
 - 2. The interior surface of the pipe shall have a coefficient of roughness of not greater than 0.013 (Manning).
 - 3. Gage of round pipe shall be not less than:

DIAMETER	GAGE
6 - 24 inches	16
30 -36 inches	14
42 -60 inches	12

4. Joint Couplings: Galvanized steel sleeve couplings coated to match the pipe.
Headwalls and End Sections: DOT, Section 707-10.

2.7 POLYETHYLENE CORRUGATED PIPE & FITTINGS

- A. Manufacturer's:
 1. Advanced Drainage Systems, Inc., 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051.
 2. Hancor, Inc., 401 Olive St., Findlay, OH 45840; (800) 847-5880.
- B. Corrugated Polyethylene Pipe and Fittings: Conform to AASHTO M-252 (4 to 10-inch diameter) or AASHTO M-294 (12 to 36-inch diameter).
 1. Coefficient of Roughness (interior pipe surface): 0.020 maximum (Manning formula).
 2. Classification: Type C.
 3. Design Strength (all sizes): 50 feet allowable height of cover.
 4. Joint Couplings: Polyethylene Couplers; snap-on type or split collar through 24-inch diameter, screw-on type where applicable.
 5. Material Properties: High-density polyethylene meeting the requirements of ASTM D 3350, Cell Classification 324420C; or ASTM 1248, Type III, Class C, Category 4, Grade P33.
- C. Corrugated Polyethylene Pipe (Smooth Interior): Conform to AASHTO M-294 (12 to 36-inch diameter).
 1. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
 2. Classification: Type S.
 3. Minimum Pipe Stiffness Values:

DIAMETER	PIPE STIFFNESS (PER ASTM D 2412)
4", 6", 8", 10", 12"	50 psi
15"	42 psi
18"	40 psi
24"	34 psi
30"	28 psi
36"	22 psi

4. Joint Couplings: Polyethylene Couplers; snap-on type or split collar through 24-inch diameter, screw-on type where applicable.
 - a. Corrugated to match pipe corrugations, width not less than one half pipe diameter.
 - b. Split couplings shall engage an equal number of corrugations on each side of the joint.
5. Joint Couplings: Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F 477.
- D. Fittings:
 1. High density polyethylene meeting the properties specified for the pipe.
 2. Either molded or fabricated.
 3. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
- E. Headwalls and End Sections: Galvanized steel manufactured from material meeting the requirements of AASHTO M-218.
 1. Conform to shape, dimensions, and thickness shown on the drawings.
 2. Use only extra length rod and lug-type, galvanized coupling band connectors.
- F. Perforated Pipe: Conform to AASHTO M-252 or AASHTO M-294, Type SP with Class I perforations.

PART 3 EXECUTION**3.0 SHORING, SHEETING, AND BRACING OF EXCAVATION**

- A. Where unstable material is encountered or where the depth of excavation in earth exceeds five (5) feet, the sides of the trench or excavation shall be supported by substantial sheeting, bracing, and shoring, or the sides sloped to the angle of repose. Sloping the sides of the ditch to the angle will not be permitted in streets, roads, narrow rights-of-way, or other constricted areas unless otherwise specified. The design and installation of all sheeting, sheet piling, bracing, and shoring shall be based on computations of pressure exerted by the materials to be retained under obtaining conditions. Adequate and proper shoring of all excavations shall be the entire responsibility of the Contractor; however, the Owner may require the submission of shoring plans (accompanied by supporting computations) for approval prior to the Contractor undertaking any portion of the work. The standards of the Federal Occupational Safety and Health Act and the Ohio Department of Labor shall be followed.
- B. Foundations, adjacent to where the excavation is to be made below the depth of the existing foundation, shall be supported by shoring, bracing, or underpinning as long as the excavation shall remain open, or thereafter if required to insure the stability of the structure supported by the foundation, and the Contractor shall be held strictly responsible for any damage to said foundations.
- C. Solid sheeting will be required for wet or unstable material. It shall consist of continuous vertical sheet piling of timber or steel with suitable wales and braces.
- D. Care shall be taken to avoid excessive backfill loads on the completed pipelines and the trench width requirements at the level of the crown of the pipe and at the level of a road or street be strictly observed.
- E. Trench sheeting shall not be removed until sufficient backfill has been placed to protect the pipe.
- F. All sheeting, planking, timbering, bracing and bridging shall be placed, renewed and maintained as long as is necessary.
- G. Contractor shall refer to the Geotechnical Soils Report (if available) prior to excavating.

3.1 PIPE BEDDING - GRAVITY SEWERS

- A. All gravity sewer pipe shall be laid on a bed of granular material except when a concrete encasement situation occurs. All pipe bedding material shall be No. 9 crushed stone aggregate and shall be placed to a depth of 4" in an earth trench and 6" in a rock trench. The Contractor will not be permitted to use dense graded aggregate material for pipe bedding.
- B. Pipe bedding shall be graded to provide for a uniform and continuous support beneath the pipe at all points.
- C. After each pipe has been brought to grade, aligned, and placed in final position, No. 9 crushed stone aggregate material shall be deposited and densified under the pipe haunches and on each side of the pipe up to the spring line of the pipe to prevent lateral displacement and hold the pipe in proper line of the pipe to prevent lateral displacement and hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations.
- D. In wet, yielding and mucky locations where pipe is in danger of sinking below grade or floating out of grade or line, or where backfill materials are of such a fluid nature that such movements of pipe might take place during the placing of the backfill, the pipe must be weighted or secured permanently in place by such means as will prove effective.
- E. Where an unstable (i.e. water, mud, etc.) trench bottom is encountered, stabilization of the trench bottom is required. This is to be accomplished by undercutting the trench depth and replacing to grade with a foundation of crushed stone aggregate. The depth of the foundation is dependent upon the severity of the trench bottom. The size of stone aggregate used in the foundation will be determined by the condition of the unstable material. Once the trench bottom has been stabilized, the required No. 9 crushed stone aggregate bedding material can be placed. No compensation for Crushed Stone for Pipe Foundation will be made if the instability of the trench bottom is caused by the Contractor's neglect.
- F. In no case shall pipe be laid directly on solid or blasted rock.

3.3 PIPE LAYING

- A. The pipe shall be protected during handling against impact shocks and free fall. Care shall be taken to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.
- B. After being delivered alongside the trench, the pipe shall be carefully examined for soundness or damage. No piece of pipe or fitting which is known to be defective shall be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. Before each piece of pipe is lowered into the trench, it shall be thoroughly cleaned out. Each piece of pipe shall be lowered separately. In the case of length of pipe being cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.
- C. The bell and spigot of the joint shall be cleaned of dirt and foreign matter immediately prior to jointing. The contact surfaces shall be coated with the lubricant, primer or adhesive recommended by the pipe pushed together until the joint snaps distinctly in place. The pushing together of the pipe may be done by hand or by the use of a bar.
- D. All pipe shall be laid straight between changes in alignment and at uniform grade between changes in grade. When jointed in the trench the pipe shall form a true and smooth line.
- E. Trenches shall be kept dry during pipe laying. Before pipe laying is started, all water that may have collected in the trench shall be removed.
- F. All pipe shall be laid starting at the lowest point and installed so that the spigot ends point in the direction of the flow.

3.4 PIPE BACKFILLING

- A. Backfilling is defined as that material which is placed over the gravity sewer from the spring line to a predetermined point above the top of the pipe according to various backfilling situation as defined in Section C, this article. The material shall be No. 9 crushed stone aggregate and may be machine placed without compaction. Uneven places in the backfill shall be leveled by hand.
- B. There are two cases where the method of backfilling varies. The various cases and their trench situations are as follow:
 - 1. Case I - Areas not subject to vehicular traffic.
 - 2. Case II - Areas under bituminous pavement.
- C. In all cases, walking or working on the completed pipelines except as may be necessary in backfilling will not be permitted until the trench has been backfilled to a point six (6) inches above the top of the pipe. The method of final backfilling for each of the above cases is as follows:
 - 1. Case I - The trench shall be backfilled from a point 6" above the top of the pipe to a point 8" below the surface of the ground with earth material free from large rock (over one-half cubic foot in volume), acceptable to the Owner. The remainder of the trench to existing grade shall be backfilled with earth material reasonably free of any rocks.
 - 2. Case II - The trench shall be backfilled to the existing grade with No. 9 crushed stone until the bituminous pavement replacement can be constructed. Extreme care shall be exercised to prevent damage to the pipe during the backfilling operation. Suitable equipment shall "walk" the trench for compaction. A slight mound may be left if, in the opinion of the Owner, the public would not be inconvenienced. Sufficient stockpiles of No. 9 crushed stone shall be placed throughout the project area to insure immediate replacement by the Contractor of any settled areas. No extra payment will be made for the filling in of settled areas by the Contractor.
- D. Excavated materials from trenches and tunnels, in excess of quantity required for trench backfill, shall be disposed of by the Contractor. The Contractor may contact the Owner regarding the location of a suitable disposal site; however, if the Owner cannot recommend a site, it shall be the responsibility of the Contractor to obtain locations or permits for the disposal of the waste material.

3.5 CONNECTION TO EXISTING MANHOLES

- A. Where an existing manhole does not have existing stubs it will be necessary for the Contractor to construct a new invert for the existing manhole.

3.6 UTILITY CROSSING CONCRETE ENCASEMENT

- A. At locations shown on the Contract Drawings, required by the Specifications, or as directed by the Owner, concrete encasement shall be used when the clearance between the proposed sewer pipe and any existing utility pipe is eighteen (18) inches or less. Utility pipe includes underground water, gas, telephone and electrical conduit, and any other pipe as determined by the Owner.
- B. There are two cases of utility crossing encasement. Case I is applicable when the proposed sewer line is below the existing utility line. Case II is applicable when the proposed sewer line is laid above the utility line. In either case, the concrete shall extend to at least the spring line of each pipe involved.
- C. Concrete shall be Class B (3000 psi) and shall be mixed sufficiently wet to permit it to flow between the pipes to form a continuous bridge. In tamping the concrete, care shall be taken not to disturb the grade or line of either pipe or damage the joints.
- D. Concrete is not a separate pay item and will be considered incidental to gravity sewer installation.

3.7 BITUMINOUS PAVEMENT REPLACEMENT

- A. Sections of pavement shall be replaced as required to install the pipelines under the work of this Section. Disturbed pavement shall be reconstructed to original lines and grades with bituminous binder as detailed on the Drawings and in such manner as to leave all such surfaces in fully as good or better condition than that which existed prior to these operations.
- B. Prior to trenching, the pavement shall be scored or cut to straight edges along each side of the proposed trench to avoid unnecessary damage to the remainder of the paving. Edges of the existing pavement shall be recut and trimmed as necessary to square, straight edges after the pipe has been installed and prior to placement of the binder course.
- C. Backfilling of trenches shall be in accordance with the applicable portions of Section 31000.
- D. Bituminous concrete binder shall be one course construction in accordance with applicable provisions of the State Department of Highways Standard Specifications.
 - 1. Placement and compaction of binder course shall be in accordance with the State Department of Highways Standard Specifications. Minimum thickness after compaction shall be as shown on the Drawings.

3.8 CRUSHED STONE BACKFILL

- A. The Class I granular material used in Case II and Case III backfill situations shall be No. 9 Crushed Stone aggregate (No. 9 Stone). Granular material will be paid for as a separate bid item.
- B. The twelve inches (12") of crushed stone backfill that is required in "City and County Maintained Streets, Roads, and Driveway Pavement Replacement" or "State Maintained Streets and Roads Pavement Replacement" will not be paid for under the provisions of this article.

3.9 CRUSHED STONE SURFACE REPLACEMENT

- A. The Class II granular material used in Case II backfill situations shall be dense graded aggregate (D.G.A.).

3.10 TESTING OF SEWERS

- A. After the gravity piping system has been brought to completion, and prior to final inspection, the contractor shall rod out the entire system by pushing through each individual line in the system, from manhole to manhole appropriate tools for the removal from the lines of any and all dirt, debris, and trash. If necessary during the process of rodding the system, water shall be turned into the system in such quantities to carry off the dirt, debris, and trash.
- B. During the final inspection, Owner's Representative may inspect each individual line, from manhole to manhole, either by use of lights, television, or other means at his disposal to determine whether the completed lines are true to line and grade as laid out or as shown on the Drawings.
 - 1. The Owner may require that the Contractor pass through the system under its own momentum a wooden ball of a diameter one inch less than the nominal diameter of the pipe, except that no ball larger than eight inches in diameter shall be used.

2. All lines or sections of lines that are found to be laid improperly with respect to line or grade, that are found to contain broken or leaking sections of pipe, or are obstructed in such a manner that they cannot be satisfactorily corrected otherwise, shall be removed and replaced at the Contractor's expense.
- C. The pipe line shall be made as nearly watertight as practicable, and leakage tests and measurements shall be made. All apparatus and equipment required for testing shall be furnished by the Contractor and the cost shall be included in the unit price bid for pipe and manholes.
 1. The Owner may require the Contractor to smoke test the first section (manhole to manhole) of each size of pipe and type of joint prior to backfilling, to establish and check laying and jointing procedures. The test shall consist of smoke blown into closed-off sections of sewer under pressure and observing any smoke coming from the pipe line indicating the presence of leaks. Other supplementary smoke tests prior to backfilling may be performed by the Contractor at his option; however, any such tests shall not supplant the final tests of the completed work unless such final tests are waived by the Owner.
 2. Where the ground water level is more than one foot above the top of the pipe at its upper end, the Contractor shall conduct either infiltration tests or low pressure air test on the completed pipeline.
 3. Where the ground water level is less than one foot above the top of the pipe at its upper end, the Contractor shall conduct either exfiltration tests or low pressure air tests on the completed pipeline.
- D. Low pressure air tests shall be made using equipment specifically designed and manufactured for the purpose of testing sewer lines using low pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal pressure in the pipeline cannot exceed 8 psig.
 1. The test shall be made on each manhole-to-manhole section of pipeline after placement of the backfill. The Engineer or his designated representative must be present to witness each satisfactory air test before it will be accepted as fulfilling the requirements of these specifications.
 2. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
 3. Low pressure air passing through a single control panel, shall be introduced into the sealed line until the internal air pressure reaches 4 psig greater than the maximum pressure exerted by ground water that may be above the invert of the pipe at the time of test. However, the internal air pressure in the sealed line shall not be allowed to exceed 8 psig. When the maximum pressure exerted by the ground water is greater than 4 psig, the Contractor shall conduct only an infiltration test.
 4. At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period the low-pressure air supply hose shall be quickly disconnected from the control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig (greater than the maximum pressure exerted by ground water that may be above the invert of the pipe) shall not be less than that shown in the following table:

<u>Pipe in Diameter in Inches</u>	<u>Minutes</u>
4	2.0
6	3.0
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5
21	10.0
24	11.5
30	13.5

5. When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter pipe in the section, and shall be the time shown in the table reduced by 0.5 minutes.
- E. Infiltration tests shall be made after underdrains, if present, have been plugged and other ground water drainage has been stopped such that the ground water is permitted to return to its normal level insofar as practicable.
 1. Upon completion of a section of the pipeline, the line shall be dewatered and a satisfactory test conducted to measure infiltration for at least 24 hours. The amount of infiltration, including manholes, tees, and connections, shall not exceed 200 gallons per nominal inch diameter per mile of sewer per 24 hours.
- F. Exfiltration tests which subject the pipeline to an internal pressure, shall be made by plugging the pipe at the lower end and then filling the line and manholes with clean water to a height of 2 feet above the top of the sewer at its upper end. Where conditions between manholes may result in test pressures which would cause leakage at the plugs or stoppers in branches, provisions shall be made by suitable ties, braces, and wedges to secure the plugs against leakage resulting from the test pressure.
 1. The rate of leakage from the sewers shall be determined by measuring the amount of water required to maintain the level 2 feet above the top of the pipe.
 2. Leakage from the sewers under test shall not exceed the requirements for leakage into sewers as herein before specified.
- G. The Contractor shall furnish suitable test plugs, water pumps, and appurtenances, and all labor required to properly conduct the tests. Suitable bulkheads shall be installed, as required, to permit the test of the sewer. The Contractor shall construct weirs or other means of measurements as may be necessary.
- H. Should the sections under test fail to meet the requirements, the Contractor shall do all work of locating and repairing the leaks and retesting as the Engineer may require without additional compensation.
- I. If in the judgment of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer. In any event, the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

3.11 TESTING OF FORCE MAINS

- A. The pipe shall be hydrostatically tested at 1.5 times the design working pressure at the point of testing. The duration of the test(s) shall be at least 2 hours during which time the pressure shall not fall more than 5 psi. The pipe shall be tested for allowable leakage according to AWWA C-600 (latest revision) concurrently with the pressure test.
- B. Where practicable, pipelines shall be tested between line valves or plugs in lengths of not more than 3000 feet. testing shall proceed from the pump station toward the termination of the line. The line shall be tested upon the completion of the first 3000 feet. After the completion of two consecutive tests without failure, the Contractor, at his option and with the Engineer's approval, may discontinue testing until the system is complete.
- C. Duration of test shall be not less than 2 hours.
- D. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with.
- E. All pipe, fittings, and other materials found to be defective under test shall be removed and replaced at the Contractor's expense.
- F. Test pressures shall not be less than 1.25 times the working pressure at the highest point along the test section, not exceed pipe or thrust restraint design pressure, not vary more than +5 psi.
- G. Before applying the specified test pressure, air shall be expelled completely from the pipe. If permanent air vents are not located at high points within the test section, the Contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water.

3.12 LEAKAGE TEST

- A. The leakage shall be defined as the quantity of water that must be supplied to the tested section to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.
- B. The allowable leakage shall not be greater than that determined by the following formula:

$$L = \frac{ND(P)}{7400}^{1/2}$$

Where L is the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

- C. All visible leaks are to be repaired regardless of the amount of leakage.
- D. or Concrete and Corrugated Pipe Sewers:
 - 1. Prior to backfilling and laying additional pipe, test the first 100 feet of sewer construction for leakage.
 - 2. Fill the sewer with water and maintain a head two feet above the highest section of Work being tested. Measure the quantity of leakage. When the sewer being tested is constructed in water bearing soil, the leakage test may, at the discretion of the Owner's Representative, be made by measuring the quantity of infiltration into the sewer. The allowable leakage or infiltration shall not be exceeded.
 - 3. The rate of leakage or infiltration shall not exceed 50 gallons per 24 hours per inch pipe diameter per 1000 feet of sewer being tested.

3.13 PLACEMENT OF IDENTIFICATION TAPE

- A. The placement of detectable underground marking tape shall be installed over all utility lines. Care shall be taken to insure that the buried marking tape is not broken when installed and shall be Lineguard brand encased aluminum foil, Type III. The identification tape is manufactured by Lineguard, Inc., P. O. Box 426, Wheaton, Illinois 60187.
- B. The identification tape shall bear the printed identification of the utility line below it, such as "CAUTION - BURIED FORCE MAIN BELOW". Tape shall be reverse printed, surface printing will not be acceptable. The tape shall be visible in all types and colors of soil and provide maximum color contrast to the soil. The tape shall meet the APWA color code, and shall be two (2) inches in width. Colors are: yellow - gas; green - sewer; red - electric; blue - water; orange - telephone; brown - force main.
- C. The tape shall be the last equipment installed in the ditch so as to be first out. The tape shall be buried 4 - 6 inches below top of grade. After trench backfilling, the tape shall be placed in the backfill and allowed to settle into place with the backfill. The tape may be plowed in after final settlement, installed with a tool during the trench backfilling process, unrolled before final restoration, or installed in any other way acceptable to the owner or his agent or engineer.

SECTION 33391 – MANHOLES, FRAMES & COVERS FOR SEWERS**PART 1 GENERAL****1.0 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Section 310000 - Earthwork
- B. Section 33310 – Drainage Pipe and Fittings for Sewers

1.2 REQUIREMENTS OF REGULATORY AGENCIES

- A. Obtain necessary permits from local Authorities. Ascertain and comply with local requirements for materials, construction and restoration of pavement.

1.3 SUBMITTALS

- A. Shop Drawings (if requested by Owner): Show fabrication details and connections to adjacent Work.
- B. Product Data (if requested by Owner): Manufacturer's catalog cuts, specifications, and installation instructions.

PART 2 PRODUCTS**2.01 MATERIALS**

- A. Precast Reinforced Concrete Manholes:
 - 1. Riser Sections: ASTM C 478.
 - 2. Joints Between Riser Sections-One of the following:
 - a. Rubber Gaskets: ASTM C 443.
 - b. Butyl Joint Sealant: ConSeal CS-202 by Concrete Sealants, Inc., 8917 S. Palmer Rd., P. O. Box 176, New Carlisle, OH 45344, (513) 845-8776.
 - 3. Concrete for Precast Units: Air content 6 percent by volume with an allowable tolerance of plus or minus 1.5 percent. Minimum compressive strength of 4,000 psi after 28 days.
 - 4. Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
- B. Glass-Fiber Reinforced Polyester Manholes:
 - 1. One-Piece Monolithic Unit: ASTM D 3753.
 - 2. Nominal Inside Diameter: 48 inches.
 - 3. Minimum Wall Thickness: 0.480 inch.
 - 4. Concentric Cone Top:
 - a. Minimum Clear Opening: 30 inches.
 - 5. Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
 - 6. Acceptable Fiberglass Manhole Manufacturers: Containment Solutions, Inc., 5150 Jefferson Chemical Rd., Conroe, TX 77301, (888) 409-7731; L.F. Manufacturing, P.O. Box 578, Highway 290 East Giddings, Texas 78942, (800) 237-5791.
- C. Precast Reinforced Square and Rectangular Concrete Structures:
 - 1. Riser Sections: ASTM C890.
 - 2. Keyed Joints:
 - a. Joint Sealant - Select One:

- 1) Mortar
 - 2) Rubber Gasket
 - 3) Butyl Joint Sealant
 3. Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
 4. Concrete for Precast Units: Air content 6 percent by volume with an allowable tolerance of plus or minus 1.5 percent. Minimum compressive strength of 4,000 psi after 28 days.
- D. Cast-in-Place Concrete for Manhole Invert Channels: Normal weight, air entrained concrete with a minimum compressive strength of 4,000 psi after 28 days.
 1. Design Air Content: 6 percent by volume plus or minus 1.5 percent.
 2. Cement: Minimum 610 pounds per cubic yard.
 3. Slump: Between 2 and 3 inches.
- E. Drop Piping:
 1. Outside Drop:
 - a. Ductile Iron Pipe: ANSI/ASTM A-746, Class 50.
 - b. Polyvinyl Chloride Pipe: PVC compound ASTM D1784, Pipe ASTM D-3034, SDR-26.
 2. Inside Drop:
 - a. Polyvinyl Chloride Pipe: PVC compound ASTM D1784, Pipe ASTM D-3034, SDR-26.
- F. Frames, Covers and Grates for Manholes and Catch Basins:
 1. Design of each shall be the same throughout the project unless otherwise specified or indicated on the drawings.
 2. Units shall meet AASHTO H20 wheel loading requirements. Manufacture, workmanship and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 3. Material:
 - a. Cast iron: ASTM A48, Class 30B or 35B.
 - b. Delivered to Site free of any coatings, unless otherwise specified.
 4. Frames:
 - a. Round with a 30-inch clear opening.
 5. Covers:
 - a. Round.
 - b. Solid lid, top surface checkered and provided with suitable concealed lifting notches, and lettering cast into cover to indicate type of structure.
 6. Grates:
 - a. Round.
 - b. Minimum open area: 232 sq inches.
 - c. Bicycle safe.
 7. Provide frames, covers, and gratings of the locking type when indicated on the drawings.
 - a. Acceptable Locking Devices: Type J or Type H by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Type A or Type B by Syracuse Casting Sales Corporation, P. O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601.
 8. Acceptable Manhole Frames and Covers: Pattern R-1557-A with platen cover by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 1012A with platen cover by Syracuse Castings Sales Corp., P. O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601.
 9. Acceptable Catch Basin Frames and Gratings: Pattern R-2557-A frame with Pattern R-2580-A, Type G grate by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 1012451XC frame with Pattern 1187025 grate by Syracuse Casting Sales Corp., P. O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601.

- G. Curb Inlet Frames, Grates and Curb Boxes:
 - 1. Designed to meet AASHTO H20 wheel loading requirements. Manufacture, workmanship and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 - 2. Material:
 - a. Cast iron: ASTM A 48, Class 30B or 35B.
 - b. Delivered to the Site free of any coatings, unless otherwise specified.
 - 3. Frames: Square top with round 36-inch OD base flange and integral stiffeners.
 - 4. Grates:
 - a. Rectangular.
 - b. Bicycle safe.
 - 5. Acceptable Curb Inlets: Pattern R-3010 with Type A grate by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 2640 by Syracuse Castings Sales Corp., P. O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601.
- H. Drop Inlet Frames and Grates:
 - 1. Designed to meet AASHTO H20 wheel loading requirements. Manufacture, workmanship and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 - 2. Material:
 - a. Cast iron: ASTM A 48, Class 30B or 35B.
 - b. Delivered to Site free of any coatings, unless otherwise specified.
 - 3. Frames: Slab type, 24-inch square clear opening.
 - 4. Grates:
 - a. Bicycle safe.
 - 5. Acceptable Drop Inlet Frames and Grates: Pattern R-3562 by Neenah Foundry Company, P. O. Box 729, Neenah, WI 54957, (414) 729-3661; Pattern 1396440 frame with Pattern 1396040 grate by Syracuse Castings Sales Corp., P. O. Box 190, South Bay Rd., Cicero, NY 13039, (315) 699-2601.
- I. Pipe-to-Manhole/Drainage Structure Connections-One of the following:
 - 1. A-Lok Flexible Connector by A-Lok Products, Inc., 697 Main St., Tullytown, PA 19007, (215) 547-3366.
 - 2. Lockjoint Flexible Connector by Chardon Rubber Company, 373 Washington St., Chardon, OH 44024, (216) 285-2161.
 - 3. Kor-N-Seal Flexible Connector by NPC, Inc., 250 Elm St., Milford, NH 03055, (601) 673-8680.
 - 4. Link-Seal Flexible Connector by Thunderline Link-Seal, Inc., 6525 Goforth St., Houston, TX 77021, (713) 747-8819.
- J. Mortar: ASTM C 270, Type M.

PART 3 EXECUTION

3.0 PREPARATION

- A. Sewer Lateral Openings in Precast and Cast-in-Place Concrete Risers: Provide openings and install pipe connectors in strict accordance with the recommendation of the connector manufacturer.

3.1 INSTALLATION

- A. Construct concrete structures with precast reinforced riser sections to the dimensions shown. Seal joints between precast riser sections with material specified.
 - 1. Wall thickness for circular structures 12 feet deep or less: 5 inches.
 - 2. Wall thickness for circular structures greater than 12 feet deep: 6 inches.
- B. Position tops of structures flush with finished grade.

- C. Form inverts in manholes on straight runs by the use of channel pipe. Form inverts in manholes at changes in direction or grade by making curved channels of concrete. Channels shall have a smooth surface free from irregularities.
- D. Cut laterals which will enter above the invert to correct length before installation. Do not cut after installation. Construct drops as shown.
- E. Install glass-fiber reinforced polyester manholes as detailed on the Drawing and in accordance with the manufacturer's printed installation procedures.
- F. Construct drop inlets of concrete or precast units.
- G. Install curb inlets where indicated.

SECTION 33462 - GEOTEXTILE SUBSURFACE DRAINAGE FILTRATION

PART 1 GENERAL

1.0 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Requirements and Division 00 Specification Sections, apply to this Section.

1.1 RELATED WORK

- A. Section 31000 - Earthwork
- B. Section 33310 – Drainage Pipe and Fittings for Sewers

1.2 SUBMITTALS

- A. Product Data (if requested by Owner): Manufacturer's catalog sheets, specifications, and installation instructions for each item specified.
- B. Samples (if requested by Owner): 12 inch x 12 inch sample of prefabricated drainage panel.

PART 2 PRODUCTS

2.0 MATERIALS

- A. Prefabricated Drainage Panel; Any of the following best fitting the specific application:
 - 1. MIRADRAIN 6000 by Nicolon/Mirafi Group, 3500 Parkway Ln., Suite 500, Norcross, GA 30092, (800) 234-0484.
 - 2. J-Drain 300 Composite Drainage System by JDR Enterprises, Inc., 725 Branch Dr., Alpharetta, GA 30201, (800) 843-7569.
 - 3. Hydraway 300 by Monsanto, 2381 Centerline Industrial Dr., St. Louis, MO 63146, (800) 325-4330.

PART 3 EXECUTION

3.1 PROTECTION

- A. Protect prefabricated drainage panel from sunlight during transportation and storage.

3.2 INSTALLATION

- A. Install the Work of this Section in accordance with the manufacturer's printed instructions.

VALVOLINE INSTANT OIL CHANGE
WILLISTON, NORTH DAKOTA
PROJECT # 26012

DIVISION 22 – PLUMBING

SECTION 220500	PLUMBING GENERAL PROVISIONS
SECTION 220510	COMMON WORK RESULTS FOR PLUMBING
SECTION 220520	GENERAL MOTOR REQUIREMENTS
SECTION 220700	PLUMBING INSULATION
SECTION 221100	PLUMBING PIPING
SECTION 221200	PLUMBING SPECIALTIES
SECTION 221300	SANITARY WASTE SPECIALTIES
SECTION 223000	PLUMBING EQUIPMENT
SECTION 224000	PLUMBING FIXTURES

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 230500	HVAC GENERAL PROVISIONS
SECTION 230510	COMMON WORK RESULTS FOR HVAC
SECTION 230520	GENERAL MOTOR REQUIREMENTS
SECTION 230530	EXCAVATION AND BACKFILL
SECTION 232000	HVAC PIPING
SECTION 233000	AIR DISTRIBUTION
SECTION 233400	FANS AND FAN SYSTEMS
SECTION 233700	AIR OUTLETS AND INLETS
SECTION 235000	CENTRAL HEATING EQUIPMENT
SECTION 235400	FURNACES
SECTION 235500	FUEL-FIRED HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Specification Format

1. These Specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractors, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "the Contractor shall", and "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, perform all indicated requirements whether stated imperatively or otherwise.
2. Three Part Format
 - a. "Part 1 - General": Covers those areas which relate to the Work, and which define the general administrative and technical requirements specific to a particular section.
 - b. "Part 2 - Products": Defines, in detail, the acceptance equipment and materials to be incorporated into the Work.
 - c. "Part 3 - Execution": Describes, in detail, the manner in which items covered by Part 2 are to be incorporated into the Work.
3. Where Codes, Specifications and Drawings are in conflict, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies immediately to the Engineer prior to commencing related work.

B. Definitions:

1. Furnish: Supply equipment as required by these Drawings and Specifications, delivered to the job site for installation or use by others.
2. Install: Fix in position for total operational use all apparatus as shown, specified or required. Provide all miscellaneous fittings and wiring supplies.
3. Or Approved Equal: Equipment or materials selected by Contractor subject to Engineer's acceptance.
4. Or Equivalent: Equipment or materials selected by Contractor matching the function and performance of equipment or materials listed.
5. Provide: Furnish and install in place, total and operational.
6. Complete/Completely: All pipes, fittings, ducts, wiring supplies, and accessories provided for the noted equipment from the equipment to the mains or noted termination points.

1.2 SCOPE OF WORK

- A. The work covered by this Division consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of the plumbing systems, in strict accordance with Division 22 of this Specification and applicable Drawings and subject to the terms and conditions of the Contract.
- B. Work of this Division is subject to requirements of Instructions to Bidders, General Conditions, Supplementary Conditions, Division One, and all other sections of this Specification.

- C. Examine site and all Contract documents prior to submittal of bid.
 - 1. Submittal of a Bid shall indicate the Contractor has examined the Site and Drawings and has included all required allowances in this Bid. No allowance shall be made for errors resulting from the Contractor's failure to visit job sites and to review Drawings.
- D. Division 22 Work: Includes, but is not limited to, providing the following:
 - 1. Potable Water Distribution System: Fixtures, piping, equipment.
 - 2. Waste and Vent Systems: Piping and specialties.
 - 3. Compressed Air Systems: Low pressure (below 150 psi) air piping.
 - 4. Medical and Laboratory Systems: Piping, controls, specialties.

1.3 ALTERNATES

- A. Refer to Division 01 for alternates.

1.4 CONTINGENCY

- A. Refer to Division 01 for amount to include in Mechanical Bid.

1.5 SUBMITTALS

- A. General:
 - 1. Preferred Submittal Format: PDF, unless otherwise noted.
 - 2. Preferred Submittal Nomenclature: Unless otherwise noted, PDF submittals are to be named according to the following:
 - a. [Specification Section Number] – [Specification Name or Equipment Included]
 - 3. Distribution: Unless otherwise noted, direct all correspondence concerning Division 22 submittals to:

Justin Byrne
PRAIRIE ENGINEERING, P.C.
1905 17TH STREET SE
MINOT, ND 58701
jbyrne@prairieengineeringpc.com

- B. Substitution and Prior Approval to Quote:
 - 1. Format and Content: Complete descriptive technical data on the proposed item consisting of model numbers, type, size and performance characteristics.
 - 2. Submission Timing: Minimum of 192 hours (eight days) prior to bid opening.
 - a. Substitutions will not be permitted after bid opening except where such substitution is considered by the Engineer to be in the best interest of the Owner.
 - 3. Bidder Notification: Prior to bid opening via Addenda, sent to all planholders.
 - 4. Contractor Responsibility: This contractor will be responsible for all coordination, construction costs, and Architectural/Engineering design fees required to substitute equipment that has different characteristics than designed including weights, physical dimensions, clearances, mechanical characteristics, electrical characteristics, and other characteristics deemed important to the design by the Architect/Engineer.
 - 5. Alternative Format: Printed paper, two copies; Self-addressed, stamped envelope required for return reply.

C. Schedule of Values

1. Format and Content: When included with the Bid, at minimum the following categories shall be indicated:
 - a. "Project mobilization"
 - b. "Demolition"
 - c. "Excavation and Backfill"
 - d. "Insulation"
 - e. "Domestic Water Piping System" (all piping, valves, shock arrestors, fittings, hangers, installed in place)
 - f. "Waste and Vent System" (all piping, valves, fittings, hangers, floor drains, interceptors, installed in place)
 - g. "Plumbing Fixtures" (all fixtures, faucets/flush valves, drain assemblies, water coolers, installed in place)
 - h. "Plumbing Equipment" (all water heaters, recirculation pumps, expansion tanks, storage tanks, installed in place)
2. Submission Timing: Prior to first payment application.

D. Shop Drawings

1. Distribution: Engineer via the Prime Contractor for each item indicated.
2. Format and Content: Include catalog numbers, performance data, dimensions and other descriptive information.
 - a. Contractor Review: Dated and signed cover sheet or review stamp for each Shop Drawing file to indicate thorough review. **Email message text not acceptable.**
 - b. Non-Conforming: Returned to Contractor without review.
3. Submission Timing: Prior to delivery of materials to job site.

E. Record Drawings

1. Format and Content: Paper copy of Drawings project site.
 - a. As work progresses, Contractor's field supervisor shall mark Record Drawings in red pencil to indicate actual conditions of installation.
 - b. Give particular attention to marking actual locations of underground piping.
 - c. Affix all addendum and change order descriptions to appropriate record drawing sheet, utilizing spray adhesive.
 - d. Make Record Drawings available to Engineer during project visitation.
2. Submission Timing: Close of project with Record Manuals.

F. Spare Equipment and Devices

1. Distribution: Owner.
2. Format and Content: List quantities on contractor letterhead or invoice, obtain signature of Owner's representative acknowledging receipt, and include with each Record Manual.
3. Submission Timing: Close of project with Record Manuals.

G. Operation and Maintenance Manuals

1. Submission Timing: Close of project, as condition of its acceptance.
2. Record Manual information shall be included for all equipment/material where Shop Drawings are required.
3. Format and Content: Two copies, Loose-leaf hardcover binders, **and** in PDF format on

CDs or USB drive.

- a. List project name, date, Contractor's name, address and telephone number on exterior label of each Record Manual and CD.
- b. Include an index sheet indicating subcontractor and subcontractor's phone number; and each major piece of equipment, supplier and supplier's telephone number. Provide tabbed dividers indicating major groupings of equipment.
- c. Include a copy of the Shop Drawings.
- d. Include all installation, operation and maintenance data packaged with any equipment.
- e. Include all signed and dated final punch lists from walkthroughs performed by the Engineer.

1.6 APPLICATIONS FOR PAYMENT

- A. Refer to Division 1 "Applications for Payment".
- B. Provide one additional copy, sent directly to the Engineer.
- C. Schedule of Values: At minimum, include items in Submittal article.

1.7 CHANGES TO CONTRACT

- A. Any required changes to the contract after bid date shall be in accordance with General Conditions/Division 1 and this section. Where any discrepancies between the sections are encountered, the more restrictive section shall apply.
- B. Proposed changes shall be accompanied with complete substantiating documentation.
 1. Provide an itemized list of quantities for materials, equipment, and supplies.
 - a. Include unit costs for each item and extended price.
 - b. Include unit labor for each item and extended time.
 2. Provide subcontractor proposals that include the same substantiating documentation.
 3. Provide quotations from suppliers for any specially ordered equipment.
- C. Material costs shall be actual costs to the contractor, obtaining the materials through normal supply channels, including trade and quantity discounts. Utilizing "suggested pricing" from national pricing organizations for unit costs shall not be accepted. Upon request, the contractor or subcontractor shall submit evidence to substantiate the costs.
- D. Labor units shall be industry accepted standard labor hours to perform one unit of work. If the work is being performed in a location that is not considered to be standard working conditions for that specific task, additional labor shall be itemized.
- E. Labor rates shall be the actual rate paid for the workman category along with associated labor burden. Labor burden shall consist only of the mandatory fringe benefits, labor taxes, and labor insurances as affected by payroll. The owner reserves the right to reject any labor burden which is inconsistent with other similar contractors or where the fringe benefit cost is in excess of established labor agreements.
- F. Allowable markups for contractor and subcontractors
 1. Overhead on work performed by own forces: 12% maximum.
 2. Profit on work performed by own forces: 10% maximum.
 3. Commission on work performed by Subcontractors: 5% maximum.
 4. Sales tax.

- 5. Bond and permit increases where applicable.
- G. No additional markups shall be allowed for:
 - 1. Field and/or office supervision/administration time.
 - 2. Tool burden.
 - 3. Shop burden.
 - 4. Overhead/Profit applied to work performed by others.
- H. Additional costs for travel and subsistence shall only be allowed if the proposal includes a request for extension of the completion date. Furthermore, those costs shall be proportional to the number of working days of the extension.
- I. Subcontractors shall compute their costs in the same manner as the contractor. Subcontractors are subject to the same markup constraints as described herein.
- J. For changes resulting in credit to the costs, no restocking fees for materials shall be applied by the contractor or subcontractors.

1.8 QUALITY ASSURANCE

- A. Qualifications of Installers
 - 1. For installation and testing, use only trained licensed and experienced workmen familiar with items required and manufacturer's recommended methods.
 - 2. In acceptance or rejection of installed work, no allowance will be made for lack of skill on the part of the workmen.

1.9 AUTHORITIES AND AGENCIES

- A. Materials, workmanship and installation: Comply with the latest editions of all applicable codes, local ordinances, industry standards, utility company regulations, insurance carrier requirements and these Specifications.
- B. Obtain and pay all permits, inspections, licenses and other charges pertaining to the Work. Upon completion of the Work, furnish proof of acceptance by proper agency having jurisdiction.
- C. Codes and standards shall include, but not necessarily be limited to, the following:
 - 1. International Energy Conservation Code (IECC);
 - 2. Uniform Plumbing Code;
 - 3. North Dakota State Building Code;
 - 4. International Building Code (IBC);
 - 5. International Mechanical Code (IMC);
 - 6. International Fuel Gas Code (IFC);
 - 7. National Fire Protection Association (NFPA) – Sections as adopted by authority having jurisdiction.
- D. The more stringent provisions shall govern where provisions of pertinent codes and standards conflict with these Specifications or Drawings. Where Codes, Specifications or Drawings differ with one another, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies to the Engineer immediately.
 - 1. Pertinent codes and standards shall not be cited to furnish less than specifically shown or specified.

2. Meeting the minimum standards of the above Codes does not permit a lower grade of construction where Plans or Specifications call for workmanship or materials in excess of Code Requirements.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 GUARANTEE AND WARRANTY

- A. Except where otherwise noted, contractor shall guarantee materials, workmanship and the proper operation of equipment for a period of one year after Owner's beneficial use of the building or mechanical system. Contractor shall correct all equipment, material and workmanship found to be defective or non-conforming to the contract documents without cost to Owner during that one year period.
- B. Guarantee shall include trips to the project site by Contractor to adjust mechanical equipment as required, ensuring it is operating as intended.
- C. Specified guarantee shall not relieve Contractor from liability arising from improper installation or non-compliance with applicable codes.

1.11 TEMPORARY FACILITIES

- A. Refer to Special Conditions and/or Division 1 for details of temporary facilities.

1.12 NOMENCLATURE

- A. Pipe sizes listed are nominal pipe sizes throughout this Division except where otherwise noted.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Material and equipment shall be as shown or specified. Provide material not specifically described but required for a complete and proper installation of the Work, subject to the acceptance of the Engineer.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- C. Owner will not be liable for material installed in non-compliance with codes, standards, and these Contract Documents.
- D. Fire Stop System material shall be by 3M "Fire Barrier", Metacaulk, Hilti, Nelson Firestop Products, or AD Fire. See Division 07 for further details on approved materials.

2.2 ELECTRIC WIRING

- A. The Division 22 Contractor shall furnish all motors, special controls and electrical devices as specified herein for proper operation of the equipment furnished.
- B. Division 26 Contractor shall furnish and install, as required, disconnects, starters, switches, etc., and do all necessary power and control wiring including the installation of electrical devices such as thermostats, humidistats, remote control panels, etc., furnished separately by Division 22 Contractor, unless otherwise noted in Equipment Specifications.

PART 3 - EXECUTION

3.1 GENERAL

- A. Engineer, Architect, or Owner shall not be responsible for the means, methods, techniques, sequences or procedures of construction selected by Contractor.
- B. Engineer, Architect, or Owner shall not be responsible for safety precautions and programs incidental to work of Contractor.
- C. It is the sole responsibility of Contractor to initiate, maintain, and supervise all safety precautions and programs in connection with the Work.

3.2 SURFACE CONDITIONS

- A. Prior to work of each Section of Division 22, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that work of this Division may be installed in accordance with all pertinent codes, regulations and standards.

3.3 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Division before, during and after installation and to protect the installed work and materials of all other trades.
- B. Plugs: Install in ends of uncompleted piping at end of each day or when work stops.
- C. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

3.4 COORDINATION

- A. Order material in a timely fashion to assure it is on the job site when required.
- B. Coordinate installation of material with schedule of other trades to prevent unnecessary delay in construction schedule.
- C. Division 22 piping, duct and equipment installations shall comply with National Electrical Code requirements 110.26 "working spaces" and "dedicated spaces". Mechanical ducts and pipes shall not be installed in the space near electrical panels/equipment defined as "working spaces" or "dedicated spaces".

3.5 DISCREPANCIES, CONSTRUCTION CONFLICTS AND DRAWINGS

- A. Discrepancies
 - 1. Prior to submitting bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification.
 - 2. The Architect, Engineer or Owner will not be responsible for any oral instructions or modifications to the contract documents prior to opening of bids.
 - 3. Written interpretation or clarification will be made by Addenda.
- B. Construction Conflicts
 - 1. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision.

2. Do not proceed with installation in area of question until conflict has been fully resolved.
3. When so directed by Engineer, Contractor shall make minor adjustment to avoid interferences with other trades. Such minor adjustments shall be performed at no additional cost to the Architect, Engineer or Owner.

C. Drawings

1. Drawings indicate extent and general layout of plumbing systems for project. Due to small scale, it is not possible to indicate all fittings and accessories that may be required. Provide such fittings and accessories as required to form a complete and operating system in general conformance with Specifications and Drawings.
2. Exact locations, distances, levels and other conditions will be governed by the structure. Field measurements shall take precedence over the Drawings. Use the Drawings and these Specifications for guidance. Secure the Architect's approval for all changes in locations.
3. Verify all measurements at site. No compensation will be made because of difference between locations shown on the Drawings and measurements at the building.
4. Refer to the architectural drawings for dimensions and locations of walls, partitions, doors, windows, ceiling heights, door swings and other details of construction.

3.6 OFFSETS

- A. Where required to allow clearance of ducts, electrical conduit and outlet boxes, beams, etc., to avoid interference with work of other trades, to increase head room under pipes or to improve the appearance of pipe work, this Contractor shall offset his pipes as directed by the Architect/Engineer.

3.7 CUTTING AND PATCHING

- A. Refer to General Conditions. Unless specifically called out to be performed by other Contractors, the Plumbing Contractor shall perform all cutting and patching required for the installation of material and equipment furnished under his Contract.
- B. Fire-Barrier Penetrations
1. Pipe penetrations through fire rated walls and floors shall be sealed with a UL classified Fire Stop System. Fire Stops shall be provided in accordance with the appropriate System No. as it relates to pipe size/Material and wall or floor rating/material.
 2. See Specification Section 220510 for other Fire-Barrier Penetration requirements.
 3. See Section 2 article "Materials" of this Specification for approved fire stop system material.
- C. Restore damaged surfaces to their original condition by skilled mechanics of the trade involved. Contractor at fault shall assume all cost.
- D. Use only rotary type drilling tools to cut concrete.
- E. Do not endanger the stability of the structure. Do not at any time cut or alter work of any other Contractor without Architect's consent.

3.8 FIELD QUALITY CONTROL

- A. Perform field tests and inspections. Test new piping and parts of existing piping that have been altered, extended, or repaired.

- B. Ceiling Inspection: An above ceiling inspection by the Architect/Engineer shall take place prior to the installation of the ceiling, to ensure that everything is properly sealed, accessible, and fire sealed if required.
- C. Piping Inspections:
 - 1. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - b. Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- D. Domestic Water Service Piping Tests: Test water service piping as required by the Authority Having Jurisdiction or the Plumbing Code, or, in absence of published procedures, as follows:
 - 1. Testing: Before the joints are covered in order for leaks to be detected.
 - 2. Pressure: Minimum of 125 psig.
 - 3. Duration: Two (2) hours.
 - 4. Valves: Operating test shall be performed on all valves when system is under full pressure to ensure proper operation. Perform multiple times during test to ensure proper operation.
 - 5. Certification: Backfilling shall not be resumed until test results and work have been approved by Architect/Engineer.
- E. Domestic Water, Sanitary, and Vent Piping Tests: Test domestic water, sanitary, and vent piping as required by the Authority Having Jurisdiction or the Plumbing Code, or, in absence of published procedures, as follows:
 - 1. Domestic Water Piping:
 - a. Pressure: Minimum of 125 psig.
 - b. Duration: Two (2) hours.
 - 2. Sewer, Soil, Waste, Drain and Vent Piping:
 - a. Procedure: Close all openings and pressurize with air.
 - b. Pressure: Minimum of 5 psig.
 - c. Duration: 15 minutes.
 - d. System may be tested in its entirety or in sections.
 - 3. Building sewer from the building to the sewer main:
 - a. Insert a test plug at the point of connection with the Public sewer.
 - b. Pressure: 10 feet water head.
 - c. Duration: 15 minutes, constant water level.
- F. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained. Piping will be considered defective if it does not pass tests and inspections.

3.9 ADJUSTING

- A. Perform the following domestic water adjustments before operation:
 - 1. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - 2. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 INSTRUCTIONS

- A. Provide written and oral operating and maintenance instructions to Owner's representatives. The oral instructions shall be given before the Owner occupies the buildings. Instructions to include **all** building's plumbing systems and equipment.
- B. Division 22 Contractor shall coordinate with Owner at Owner's convenience, formal instruction time for contractor personnel to instruct Owner's Representatives on all equipment. Provide similar equipment supplier's instructions where specified thus.
- C. Formal instructions shall be video recorded when required by other Sections of this Specification by this Contractor. Format shall be DVD. Formal instruction to be included with each Record Manual, being referenced to and a part of the Manual.

3.11 CLEAN UP

- A. Each Contractor shall be responsible for cleaning up after his work, including the removal of all scrap material left on the job by his men or Subcontractors. This will include the removal of all pipe cuttings, pieces of pipe and insulation and other debris.
- B. After all tests have been made and the plumbing systems are operating properly, this Contractor shall go over the entire system and remove labels from all plumbing fixtures and other plumbing equipment.
- C. All equipment having finished paint surfaces shall be examined upon completion for scratches and other damage. Touch up all surfaces as required with paint of color to match factory finish.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
 - 4. Gauges (temperature, pressure)
 - 5. Hangers.
 - 6. Sleeves.
 - 7. Sleeve-seal systems.
 - 8. Escutcheons.
 - 9. Thermowells.
 - 10. Gage attachments.
 - 11. Equipment and Warning labels.
 - 12. Pipe labels.
 - 13. Equipment supports.
 - 14. Fire-Barrier Penetrations.
 - 15. Water Meter.
- B. Nomenclature:
 - 1. SWP: Steam working pressure.
 - 2. CWP: Cold working pressure.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 220500.
 - 1. Product Data: Each type of valve, gauge, strainer, sleeve, and sleeve-seal system.
 - 2. Fire-Barrier Penetrations: UL Classified System, System Number.
- B. Operation and Maintenance Manual: Per section 220500.

PART 2 - PRODUCTS

2.1 VALVE MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
 - 1. Anvil International.
 - 2. Conbraco Industries, Inc.; Apollo Valves.
 - 3. Milwaukee Valve Company.
 - 4. NIBCO INC.
 - 5. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- B. All manufacturers are subject to compliance with requirements
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.

- B. Standard and Rating: Comply with NSF-61-G.

2.3 BALL VALVES

- A. Two-Piece, Full-Port, Metal, Ball Valves:

1. Standard and Rating: 250 psi CWP at maximum 250°F.
2. Body Design: Two piece
3. Body Material: Forged brass or Bronze.
4. Seats: PTFE or TFE.
5. Stem: Brass or Bronze, blowout-proof, packing nut.
6. Ball: Chrome-plated brass.
7. Port: Full or Regular.
8. Operator: Lever; separate lever nut.

2.4 BUTTERFLY VALVES

- A. Iron, Single Flange Butterfly Valves:

1. Basis of Design: Nibco LD 2000
2. Standard and Rating: MSS SP-67, 200 psig, 5°F to 250°F.
3. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange; extended neck.
4. Body Material: Epoxy coated; ASTM A 126, cast iron or ASTM A 536, ductile iron; EPDM seat.
5. Stem: One- or two-piece stainless steel.
6. Disc: Aluminum bronze.
7. Operator: Lockable handle for 5" and smaller, gear for 6" and larger.

2.5 CHECK VALVES

- A. Check Valve – Bronze Swing:

1. Standard and Rating: 200 psig CWP at 100°F.
2. Body Design: Y-pattern.
3. Body Material: Bronze.
4. Disc: Bronze or PTFE.

- B. Check Valve – Iron, lead free:

1. Basis of Design: Nibco F-910-B-LF, flanged, lead free.
2. Standard and Rating: MSS SP-125; NSF-61-G; 200 psi CWP, 200°F.
3. Body Design: Horizontal inline with sliding disc.
4. Body Material: ASTM A 126, gray iron.
5. Actuator: Stainless steel spring.
6. Seat and Disc: ASTM B584 Bronze.

2.6 STRAINERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Watts International.

- B. Body: Brass with threaded screen retainer cap.

- C. Strainer Screen: 20-mesh brass or stainless steel.

2.7 GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Miljoco Corporation.
 - 2. Trerice, H. O. Co.
 - 3. Weiss Instruments, Inc.
 - 4. WIKA Instrument Corporation - USA.
 - 5. Winters Instruments - U.S.
- B. Bimetallic-actuated thermometers:
 - 1. Case: Aluminum with 3-inch nominal diameter.
 - 2. Dial: White with permanent scale markings and scales in deg F.
 - 3. Window: Plain glass or plastic.
 - 4. Ring: Stainless steel.
 - 5. Element: Bimetal coil.
 - 6. Pointer: Dark-colored metal.
- C. Thermometers – 6” Industrial-Style, Liquid-in-Glass:
 - 1. Basis of Design: Weiss Instruments model HW5A2.
 - 2. Case: Plastic or cast aluminum; 6-inch nominal size.
 - 3. Case Form: Adjustable angle.
 - 4. Tube: Glass with magnifying lens and blue or red non-toxic liquid.
 - 5. Tube Background: Permanent scale markings graduated in deg F.
 - 6. Stem: Brass or Aluminum and of length to suit installation.
- D. Thermometers – Digital:
 - 1. Basis of Design: Weiss Instruments DVU series.
 - 2. Case: Hi-impact plastic or cast aluminum.
 - 3. Case form: Adjustable angle.
 - 4. Display: 1/2” LCD digits, wide ambient formula
 - 5. Power Source: Integral solar cell.
- E. Pressure Gages – Dial Type:
 - 1. Basis of Design: Weiss Instruments 4UG series.
 - 2. Standard: Conform to ASME B40.100.
 - 3. Case: Cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Pressure-Element Assembly: Bourdon tube
 - 5. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 6. Dial: White aluminum with scale markings graduated in psi.
 - 7. Scale: Select so expected pressure reading is in center of range.

2.8 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: Clevis type with locknut to threaded extension rod, factory-fabricated components; MSS SP-58 types 1 through 58.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or cadmium plated steel.
- B. Copper Pipe Hangers:
1. Description: Clevis type with locknut to threaded extension rod, copper-coated-steel, factory-fabricated components; MSS SP-58 types 1 through 58.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
- C. Trapeze Pipe Hangers:
1. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- D. Plastic Pipe Support Channel
1. Description: 18 Ga. steel v-channel; standard finish.

2.9 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier for cold piping.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.10 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.11 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

2.12 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.13 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the

following or other prior approved:

1. Metraflex Company (The).
 2. Link-Seal; Pipeline Seal & Insulator, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Glass reinforced plastic.
 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.14 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

2.15 EQUIPMENT AND WARNING LABELS

- A. General Requirements
1. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 2. Minimum Letter Size: 1/2 inch for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 3. Fasteners: Stainless-steel rivets or self-tapping screws.
 4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Metal Labels for Equipment:
1. Material and Thickness: Non-corroding metal, 20 gauge minimum thickness, and having predrilled or stamped holes for attachment hardware.
- C. Plastic Labels for Equipment and Warning:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Equipment Label Color: Black letters on white background.
 3. Warning Label Color: White letters on red background.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Warning Label Content: Include caution and warning information, plus emergency notification instructions.
- E. Equipment Label Content: Include equipment's Drawing designation or unique equipment number.
- F. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing plan numbers where equipment is indicated, plus the Specification Section number and title where equipment is specified. Equipment schedule shall be provided to the Controls Contractor and included in operation and maintenance data.

2.16 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering

indicating service, and showing flow direction.

- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.17 FIRE-BARRIER PENETRATIONS

- A. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with Approved firestop materials. See Section 220500 for further details.

2.18 WATER METER

- A. Furnish and install a 2" meter of the type approved by the Water Department.
 - 1. Meter shall have a self-generating remote readout.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves where shown on drawings.
- C. Install valves in horizontal piping with stem at or above center of pipe in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, or butterfly valves.
 - 2. Pump-Discharge Check Valves:
 - a. 2" and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Arrange for grouping of parallel runs of horizontal piping, and support together on trapeze pipe hangers.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

- D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. 4" and smaller: 12 inches long and 0.06 inch thick.
 - b. 5" and larger: 18 inches long and 0.06 inch thick.
 - 5. Pipes 8" and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- J. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- K. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- L. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- M. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- N. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- O. Use thermal-hanger shield inserts for insulated piping and tubing.
- P. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping

system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 °F piping installations.
- Q. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20 or 25): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod.
- R. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- S. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
- T. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

3.4 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 1 inches above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls.

3.6 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in below grade exterior concrete walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.7 GAUGE INSTALLATION

- A. Install thermowells with extension on insulated piping.
- B. Fill thermowells with heat-transfer medium.
- C. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- D. Install thermometers in the following locations:
 1. Outlet of each water heater.
 2. Inlet of each water heater after recirculation connection.
- E. Install pressure gages in the following locations:
 1. Building water service entrance into building.

3.8 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.9 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run.

3.10 ESCUTCHEON AND FLOOR PLATE INSTALLATION

- A. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors of finished areas.

- B. Install escutcheons for piping penetrations of walls within concealed cabinet spaces.
- C. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- D. Replace broken and damaged escutcheons using new materials.

3.11 FIRE-BARRIER PENETRATION PROTECTION

- A. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- B. Install Fire Stop Systems per the manufacturers guidelines.

3.12 WATER METER INSTALLATION

- A. Install a ball valve on each side of the meter. Construct a steel angle frame or pour a concrete pad under meter to support weight. Paint support frame black.
- B. Where required by local authority: Install a bypass line with valve parallel to the meter.

3.13 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe 2" and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full or regular port, brass or bronze.
 - 3. Check Valve – Bronze Swing.
- B. Pipe 2-1/2" and Larger:
 - 1. Butterfly Valves.
 - 2. Check Valves: Bronze Swing.

3.14 GAUGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping Thermometer: 0 to 100°F.
- B. Scale Range for Domestic Hot-Water Piping Thermometer: 30 to 240°F.
- C. Scale Range for Water Service Piping Pressure Gauge: 0 to 100 psi.
- D. Scale Range for Domestic Water Piping Pressure Gauge: 0 to 100 psi.

3.15 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Galvanized-steel sleeve.
 - 2. Interior Concrete Walls above Grade:
 - a. PVC sleeve.
 - b. Cast iron sleeve.
 - 3. Exterior Concrete Walls below Grade:
 - a. Galvanized-steel wall sleeves with sleeve-seal system.
 - b. Select sleeve size to allow for 1-inch annular clear space between piping and

sleeve for installing sleeve-seal system.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Common motor requirements for Plumbing equipment.
 - a. General requirements for motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Common requirements for variable frequency drives (VFD) for Plumbing equipment.
 - a. Section includes VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 VFD QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.3 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Motor Characteristics:
 - 1. Duty: Continuous duty at ambient temperature of 105 °F and at altitude of 3500 feet above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.2 SINGLE PHASE MOTORS

- A. Description: Single phase motor, T-Frame, 1.25 service factor, minimum class B insulation for 105°F ambient.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. Reliance.
 - 3. General Electric.
 - 4. Marathon.

- 5. Century.
- C. Motors 1/20 HP and Smaller: Shaded-pole type.
- D. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- E. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- F. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- G. Minimum Efficiency: 75 percent.
- H. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.3 THREE-PHASE MOTORS

- A. Description: NEMA MG-1, T-frame, Design B, induction-type motor, minimum class F insulation for 105°F ambient.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. General Electric.
 - 3. Marathon.
 - 4. WEG.
 - 5. TECO.
 - 6. NIDEC.
- C. Materials:
 - 1. Windings: Copper.
 - 2. Frame: Steel or cast iron.
 - 3. Rotor: Random-wound, squirrel cage.
 - 4. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading, L-10 life of 200,000 hours.
- D. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
- E. Service Factor:
 - 1. 1 HP and Smaller: 1.25
 - 2. Above 1 HP: 1.15
- F. Full-load Electrical Efficiency: Based on motor size as indicated below, and shall comply with ASHRAE 90.1-2013, whichever is greater:

1. 1 HP and Smaller: 81.5%
2. Above 1 HP to 5 HP: 86.5%
3. Above 5 HP: 91%

G. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

2.4 THREE-PHASE MOTORS USED WITH VFD

- A. Description: Additional requirements for three-phase motors used with variable frequency controllers (VFD).
- B. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- C. Motors Used with Variable Frequency Controllers:
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.5 SHAFT GROUNDING RINGS

- A. Description: Conductive microfiber shaft grounding ring.
1. Meet NEMA MG-1 requirements.
 2. Factory installed whenever possible.
- B. Basis of Design: AEGIS, model SGR.
- C. Type: Minimum of two rows of circumferential fibers on solid ring or split ring.
- D. Application Note: Provide on motors greater than 1 HP.
1. Motors less than 100 HP: Mount ring on either the drive end or non-drive end.
 2. Motors 100 HP and above: Two shaft grounding rings, mounted on the drive end and the non-drive end.

2.6 ELECTRONICALLY COMMUTATED MOTORS

- A. Description: Brushless DC motor with built in speed and torque controls.
- B. Rotor: Permanent magnet.
- C. Circuitry: Programmable, manage commutation of stator to be always synchronous with rotor.
- D. Multispeed Motors: Minimum turndown of 80%.
- E. Efficiency: Minimum of 65%.
- F. Bearings: Permanently lubricated, heavy duty ball bearings.
- G. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature

returns to normal range.

2.7 VARIABLE FREQUENCY DRIVES

- A. Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter).
 - 1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. Cerus Industrial.
 - 3. Danfoss Inc.; Danfoss Drives Div.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 5. General Electric Company.
 - 6. Rockwell Automation, Inc.; Allen-Bradley Brand.
 - 7. Square D; a brand of Schneider Electric.
 - 8. Toshiba International Corporation.
- C. VFD General Requirements: Comply with NEMA ICS 7, NEMA ICS 61800-2.
 - 1. Integral Disconnect: Disconnect shall remove all power from unit.
- D. Application: Variable torque.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10% and minus 15% of VFD input voltage range rating; +/- 5% of VFD frequency rating.
 - 2. Output Rating: 3-phase; 10 to 120 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
 - 3. Environmental Operating Conditions: 32°F to 104°F, 0 to 3,300 feet above sea level, less than 95% (non-condensing).
 - 4. Minimum Efficiency: 96% at 60 Hz, full load.
 - 5. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 - 6. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
 - 7. Speed Regulation: Plus or minus 5%.
 - 8. Output Carrier Frequency: Selectable; 0.5 to 8 kHz.
- G. Inverter Logic: Microprocessor based, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 40:1 speed range.
- I. Internal Adjustability Capabilities:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration and Deceleration: 0.1 to 900 seconds.

4. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 3. Under- and overvoltage trips.
 4. Inverter overcurrent trips.
 5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 8. Loss-of-phase protection.
 9. Reverse-phase protection.
 10. Short-circuit protection.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Input Line Reactance: Provide a minimum of 5% impedance on the input to the drive. If the standard drive design does not meet the specification of 5%, additional inductors shall be provided to bring the drive up to the specified level.
1. Line reactors: Furnished and installed by the drive manufacturer in the VFD enclosure from the factory. Field installed line reactors shall not be allowed.
- P. Harmonic Mitigation:
1. DC bus reactors or Input AC line reactors.
 2. Total Harmonic Distortion: Not exceed 10%.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors and accessories according to manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

3.2 SHAFT GROUNDING RINGS

- A. Shaft grounding rings (SGR) shall be factory installed inside the motors by the manufacturer wherever possible. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating, or approved equal, on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
- B. Install and test SGR's in accordance with manufacturer's recommendations. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy, or approved equal, to secure the screws in place.
- C. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Depending upon the condition of the shaft, it may require using emery cloth or Scotch-Brite. If the shaft is visibly clean, a non-petroleum based solvent may be used to remove any residue. Check the conductivity of the shaft using an ohm meter. Ohms test: Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Each motor will have a different reading but in general one should have a maximum reading of less than 2 ohms. If the reading is higher, clean the shaft again and retest.
- D. After motors with SGR are fully installed in the field (in equipment, assemblies, or individually), for both factory-installed-SGR and field-installed-SGR cases, test for a conductive path to ground using an Ohm meter. Place one probe on metal frame of SGR and one probe on motor frame. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic water piping.
- B. The work covered by this Specification consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of all insulation for the plumbing systems, in strict accordance with Section 220700 of this Specification and applicable Drawings and subject to the terms and conditions of the Contract.

1.2 REFERENCE

- A. Related work in Section 230700 "HVAC Insulation."

1.3 SUBMITTALS

- A. Shop Drawings: For materials covered under this section as per Section 220500.
- B. Operation and Maintenance Manual: Per section 220500.
 - 1. Product Data: Each type of insulation.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. All insulation shall be installed in a workmanlike manner by skilled workmen regularly engaged in this type of work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
 - 1. Owens-Corning Fiberglass.
 - 2. Johns Manville.
 - 3. Knauf Insulation.
- B. All manufacturers are subject to compliance with requirements.
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 COMMON INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

2.3 INSULATION JACKETS

- A. ASJ Max Jacket: Poly-encapsulated paper jacket; Factory applied shall comply with ASTM C1136, Type I, II, III, IV.
- B. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; Factory applied shall comply with ASTM C 1136, Type II.

2.4 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.5 SEALANTS

- A. Joint Sealants: Permanently flexible, elastomeric sealant, compatible with insulation materials, jackets, and substrates.

2.6 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

2.7 TAPES

- A. Tapes: Match jacket with compatible adhesive as recommended by jacket manufacturer.
- B. ASJ Max Tape: Foil-face, vapor-retarder tape; complying with ASTM C 1136, 3 inches wide.
- C. FSK Tape: Foil-face, vapor-retarder tape; complying with ASTM C 1136, 3 inches wide.

2.8 SECUREMENTS

- A. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - 1. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 2. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - 3. Adhesive-backed base with a peel-off protective cover.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 12 gauge nickel-copper alloy or 14 gauge soft-annealed, stainless steel or 14 gauge soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of pipes and fittings.
- C. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- D. Install insulation with jackets as follows:
 - 1. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip.
 - 2. Overlap jacket longitudinal seams at least 1-1/2 inches. Staple laps with outward clinching staples along edge.
 - 3. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- E. Insulation Installation on Fittings, Valves, and Unions:
 - 1. Install with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate fittings and specialties using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive.
 - 3. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic and reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 4. Stencil or label the outside insulation jacket of each union with the word "union."
- F. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

- A. Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire-rated wall and partition penetrations.
 - 1. See Specification Section 220510 for further Fire-Barrier Penetration requirements.
- C. Floor Penetrations: Install insulation continuously through floor penetrations. Seal penetrations through fire-rated assemblies.
 - 1. See Specification Section 220510 for further Fire-Barrier Penetration requirements.

3.4 FIBERGLASS PREFORMED PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.5 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.6 PIPING INSULATION SCHEDULE

A. Indoor, Aboveground:

1. Domestic Cold, Hot, and Recirculating Hot Water:
 - a. 1-1/4" and smaller: Fiberglass, 1" thick.
 - b. 1-1/2" and larger: Fiberglass, 1-1/2" thick.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Pipe and fitting materials, and joining methods for the following:
 - a. Domestic water distribution piping.
 - b. Sanitary waste and vent.

1.2 REFERENCE

- A. Refer to Section 220510 "Common Work Results for Plumbing" for requirements of hangers, sleeves, sleeve seals, and escutcheons.

1.3 SUBMITTALS

A. Shop Drawings: For equipment covered under this section as per Section 220500.

1. Product Data: Provide a separate shop drawing for each of the following piping systems showing the material and fastening method chosen by the contractor:
 - a. Aboveground domestic water.
 - b. Underground domestic water.
 - c. Aboveground sanitary waste and vent.
 - d. Underground sanitary waste and vent.

- B. Operation and Maintenance Data: Equipment listed under Product Data article above as per Section 220500.

1.4 QUALITY ASSURANCE

- A. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."
- B. Non-potable water piping materials shall bear stamp or other markings of testing agency.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper
- B. Soft Copper Tube: ASTM B 88, Type K, annealed temper.
- C. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- D. Grooved-End Copper Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Anvil International, Inc.
 - b. Victaulic Company.

2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 °F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- F. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- G. Copper Pressure-Seal-Joint Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Apollo Valves.
 - b. NIBCO, Inc.
 - c. Viega, LLC.
 2. Fittings for 2" and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 3. Fittings for 2-1/2" to 4": Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
1. Standards: ASTM C 1277 and CISPI 310.
 2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
1. Standards: ASTM C 1277 and ASTM C 1540.
 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 3. Drainage pattern per ASTM D3311.
 4. Flame Spread: Less than 25 per ASTM E84/UL723.
 5. Smoke Developed Index: Less than 50 per ASTM E84/UL723.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

2.4 HIGH DENSITY POLYETHYLENE (HDPE) PIPING

- A. All pipe and heat-fused materials shall be manufactured from a virgin polyethylene extrusion compound material in accordance with ASTM-D2513, sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness, and respective tolerances as specified in ASTM D-3035 or D-2447.

- B. The material shall have a Hydrostatic Design Basis of 1600 psi at 73°F per ASTM D-2837. The material shall be a high-density polyethylene compound having a minimum cell classification of PE345464C per ASTM D-3350.
- C. Dimensions
 - 1. Smaller than 3" shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 11.
 - 2. 3" and larger shall be manufactured in accordance with ASTM F714 with a minimum dimension ratio of 17.
- D. Heat fused fittings in accordance with pipe manufacturer's procedures.
- E. Fusion transition fittings with reinforced threads shall be used to adapt to metal or reinforced hose connection fittings. Barbed fittings are not an acceptable transition to polyethylene pipe.

2.5 PP POTABLE PIPING AND FITTINGS

- A. PP Potable Pipe and Fittings: ASTM F 2389, pipe extruded and drainage-pattern fittings molded, from virgin PP-R resin; with heat fusion-joint ends.
 - 1. Domestic hot water piping shall contain a fiber layer to restrict thermal expansion.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or prior approved:
 - 1. Aquatherm Green Pipe from Aquatherm, NA.
- C. Transition Fittings: Threaded transition fittings shall be used where a threaded connection is required..

2.6 PIPING JOINING MATERIALS

- A. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- B. Joining system for FRP as recommended by manufacturer.

2.7 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings shall be CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions, and one end with threaded brass or stainless steel insert and one solvent-cement-socket end.
- B. Plastic-to-Metal Transition Unions shall be CPVC four-part union with brass threaded end, solvent-cement-joint plastic end, rubber O-ring gasket, and union nut.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 °F.
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping.
- B. In general, it is intended that piping be installed parallel to building lines, unless otherwise shown on the Drawings, and that equipment be located symmetrical with the architectural elements of the building.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Exposed piping shall be run as high as possible except where noted otherwise.
- D. Piping shall be fabricated from Contractor's Shop Drawings or field measurements and not from Contract Drawings.
- E. Extend plumbing piping to 5 feet from outside face of building wall for connection to building services, including water, fire, waste, and storm piping.
- F. This Contractor shall verify all inverts of existing mains and elevations with reference to existing and finish grades. Minimum depth of bury for water lines is 8'0".
- G. On water-supply and fire-service lines 4" and larger, install poured concrete thrust blocks at tees, elbows and at base elbow on domestic and fire water service risers in building. Blocks shall be poured against undisturbed earth of trench wall.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install waste piping 3" and smaller at 1/4" slope, and 4" and larger at 1/8" slope. Vent and storm piping shall be 1/8" slope, unless otherwise noted.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221300 "Sanitary Waste Piping Specialties."
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.

- Q. Install sleeve seals for piping penetrations of below grade concrete walls and slabs.
- R. Install escutcheons (chrome plates) for exposed piping penetrations of finished walls, ceilings, and floors.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Aboveground Domestic Water Piping 2" and Smaller: Plastic-to-metal transition fittings.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for 2" and Smaller: Use dielectric unions.

3.5 FIRE SERVICE INSTALLATION

- A. Flange on fire sprinkler line shall be installed level with bolt pattern on flange set so valve stems connected to line can be installed parallel or perpendicular to wall.
- B. Fire sprinkler line flanges shall be secured to floor/wall with threaded rod that has been securely fastened to concrete floor or wall.
- C. Cad weld magnesium sacrificial anode to the ductile iron fire riser per detail noted on the drawings.
- D. Install anti-seize compound to ease installation of fittings.
- E. Install retainer glands on elbow at riser.
 - 1. Retainer glands and restraint rings shall be Ebaa 'Megalug' type with wedge style design.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 50 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 50 feet or longer.
 - 3. Install trapeze hanger for multiple parallel piping 50 feet or longer.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- B. Install hangers for steel piping as follows:
 - 1. 1" and smaller: 8 feet with 3/8-inch rod.
 - 2. 1-1/4" to 3": 10 feet with 3/8-inch rod.
 - 3. 4" to 6": 12 feet with 1/2-inch rod.
 - 4. 8" and larger: 12 feet with 5/8-inch rod.
- C. Install hangers for drawn-temper copper piping as follows:

1. 1-1/2" and smaller: 6 feet with 3/8-inch rod.
 2. 2" to 4": 10 feet with 3/8-inch rod.
 3. 6" and larger: 10 feet with 1/2-inch rod.
- D. Install hangers for CPVC and PVC as follows:
1. 1" and smaller: 3 feet with 3/8-inch rod; 8 feet with pipe support channel and 3/8" rod.
 2. 1-1/4" to 3": 4 feet with 3/8-inch rod; 8 feet with pipe support channel and 3/8" rod.
 3. 4" to 6": 4 feet with 1/2-inch rod; 10 feet with pipe support channel and 1/2" rod.
 4. 8" and larger: 4 feet with 5/8-inch rod; 10 feet with pipe support channel and 5/8" rod.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- F. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

3.7 FIELD QUALITY CONTROL, ADJUSTING, CLEANING

- A. Comply with requirements in Section 220500 "Plumbing General Provisions".

3.8 PIPING SCHEDULE

- A. Do not use flanges or unions for underground piping.
- B. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- C. Piping materials are identified below. If more than one material is listed for an application, selection from materials listed is Contractor's option.
- D. Under-building-slab, domestic water, building-service piping:
1. 3" and smaller:
 - a. HDPE; heat fused fittings in accordance with pipe manufacturer's procedures.
 - b. Soft copper tube, Type K, Type L; wrought-copper, solder-joint fittings; and brazed joints.
 2. 3" and larger: Bell and spigot, ductile-iron pipe.
- E. Aboveground domestic water piping:
1. All sizes: Hard copper tube, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 2. 1" and smaller: PEX tube; fittings for PEX tube; and crimped joints.
 - a. PEX shall only be used for final fixture connections.
 3. 2" and smaller: Hard copper tube, Type M; cast- or wrought-copper, solder-joint fittings; and soldered joints.
 4. 2-1/2" and larger: Hard copper tube, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
 5. 4" and smaller: Hard copper tube, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
 6. 4" and smaller: CPVC, Schedule 40 socket fittings; and solvent-cemented joints.
- F. Change of direction fittings for vent, soil, and waste pipe:
1. Soil and waste piping: Long-sweep bends.
 2. Vertical stacks change of direction from horizontal to vertical: Sanitary tees and short-sweep 1/4 bends acceptable.

3. Back to back or side by side fixtures with common drain pipe: Long turn, double Y-branch and 1/8-bend fittings.
- G. Aboveground, vent, soil, and waste piping:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - a. Exception: PVC shall not be used for 20 feet from waste receptacle where waste stream is 140°F or greater, such as from commercial dishwashers.
 - b. Exception: PVC shall not be used in return air plenum spaces.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
 4. Additional option for piping 4" and smaller: Copper DWV tube, copper drainage fittings, and soldered joints.
- H. Underground, vent, soil, and waste piping:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - a. Exception: PVC shall not be used for 20 feet from waste receptacle where waste stream may exceed 140 °F, such as from commercial dishwashers.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Flowmeters.
4. Thermostatic recirculation valve.
5. Water tempering valves.
6. Tempering Valve – Emergency
7. Hose bibbs.
8. Drain valves.
9. Water-hammer arresters.
10. Double hose bibb outlet connection outlet box.
11. Compression outlet connection outlet box.
12. Potable Water Expansion Tanks.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 220500.
- B. Operation and Maintenance Manuals: For equipment covered under this section as per Section 220500.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig minimum unless otherwise indicated.
- B. For products where a list of pre-approved manufacturers is not provided, the submitted product must be equivalent to the indicated basis of design.

2.2 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
1. Basis of Design: Watts Regulator Co. LF288A.
 2. Standard: ASSE 1001.
 3. Size: 1/4" to 3", as required to match connected piping.
 4. Body: Bronze.
 5. Finish: Rough bronze.

2.3 BACKFLOW PREVENTERS

- A. Description: Potable water protection valve assemblies.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Apollo Valves.
 2. Watts.

3. Zurn.

C. Reduced-Pressure-Principle Backflow Preventers:

1. Basis of Design: Watts Regulator Co. 009.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze for 2" and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for 2-1/2" and larger.
6. Configuration: Designed for horizontal, straight-through flow.
7. Accessories:
 - a. Valves 2" and Smaller: Ball type.
 - b. Valves 2-1/2" and Larger: Outside-screw and yoke-gate type.
 - c. Air-Gap Fitting: Matching backflow-preventer connection.

2.4 WATER PRESSURE REDUCING VALVES

A. Description: Inline, lead free water valve for reducing building pressure to acceptable levels.

1. Basis of Design: Watts LFF Series.
2. Standard: ASSE 1003 compliant.
3. Material: Lead free brass body with stainless steel seat.
4. Suitable for pressures up to 300 PSI.
 - a. Setting: 60 PSI or as indicate on water meter detail on the Drawings.
5. Provide lead free strainer in-line with unit.
6. Include low-flow valve as required.

2.5 FLOWMETERS

A. Description: Inline spring and piston type flowmeter.

1. Basis of Design: Omega Easy-view Flowmeter, model FL-9000.
2. Material: Clear polysulfone, T300 series stainless steel spring, Buna flow indicator ring, Buna O-rings (on units with brass end fittings).
3. Ratings: 250°F, 325 psig.

2.6 THERMOSTATIC RECIRCULATION VALVE

A. Description: Self-contained, automatic, thermally actuated valve to regulate the distribution of hot water in multiple circuits.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Therm-Omega-Tech, Inc.

C. Standard and Rating: Comply with NSF-61-G; 200 psi and 300°F.

D. Body and Internal Component Materials: Type 303 stainless steel.

1. Spring Material: Stainless steel.

E. Valve Function: Independent of system operating pressure.

1. Actuator: Spring operated and self-cleaning, rated for 200,000 cycles min.
2. Allow minimum flow bypass when fully closed.

3. Factory adjustable from 105°F to 140°F as required by project conditions.
 4. Modulate between open and closed position within a 10°F range.
 5. Allow higher water temperatures during thermal disinfection process.
- F. Assembly: Factory provide and assembled.
1. Isolation ball valves.
 2. Thermometer: Dial type, with thermowell.
 3. Strainer: Y-type.

2.7 WATER TEMPERING VALVES

- A. Description: Water-temperature limiting devices for public lavatories:
1. Basis of Design: Watts Regulator Co. LFUSG-B, LFMMV.
 2. Standard: ASSE 1070.
 3. Type: Thermostatically controlled, water mixing valve.
 4. Material: Bronze body with corrosion-resistant interior components.
 5. Wetted surface shall be less than 0.25% of lead by weight.
 6. Cross Flow Protection: Integral check valves and integral screens.
 7. Minimum Flow: 0.5 gpm.
 8. Tempered-Water Setting: 120°F.

2.8 TEMPERING VALVE - EMERGENCY

- A. Description: Emergency shower/eyewash thermostatic mixing valve.
- B. Manufactures: subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Acorn Engineering Company.
 2. Armstrong International, Inc.
 3. Lawler Manufacturing Co., Inc.
 4. Leonard Valve Company.
 5. Powers; Watts Water Technologies, Inc.
 6. Symmons.
- C. Basis of Design: Lawler 911E, and Lawler 911E/F.
1. Standard: ANSI Z358.1, ASSE 1071.
- D. Valve:
1. Material: Corrosion resistant metal, rough bronze finish.
 2. Operation: Thermostatic.
 3. Failure:
 - a. In case of unit failure to continue cold-water flow.
 - b. In the event of cold water interruption, the control mechanism shall shut off the hot water port.
 - c. In the event of hot water interruption, the control mechanism shall allow cold water flow through both the fixed and variable cold water bypass.
 - d. In the event the liquid motor fails, the control mechanism shall close off hot water and fully open the variable cold water bypass to allow for cold water flow.
 4. Outlet Temperature Control: Adjustable between 70 – 90°F.
 5. 911 output: 25 to 60 gpm at 30 PSI; 85°F water, plus or minus 5°F.

6. 911E output: 9 to 25 gpm at 30 PSI; 85°F water, plus or minus 5°F.
 7. 911 E/F output: 2 to 7 gpm at 30 PSI; 85°F water, plus or minus 5°F.
 8. Temperature Adjustment: Vandal Resistant.
- E. Temperature Gauges: Dial type, provided and installed by manufacturer.
1. 911 E: On outlet.
- F. Accessories:
1. Stainless steel, for surface mounting and with lockable hinged door.
 2. Include check valves on both hot and cold-water inlets, provided, installed and tested by manufacturer.
 3. Include lockable ball valves on both hot and cold-water inlets, provided, installed and tested by manufacturer.

2.9 HOSE BIBBS

- A. Hose Bibbs:
1. Basis of Design: Watts Regulator Co. SC8.
 2. Body Material: Bronze.
 3. Seat: Bronze, replaceable.
 4. Outlet Connection: Garden-hose thread.
 5. Vacuum Breaker: Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 6. Equipment Rooms: Rough bronze finish, wheel handle operation.
 7. Finish for Service Areas: Rough bronze finish, wheel handle operation.
 8. Finish for Finished Rooms: Chrome or nickel plated finish, wheel handle operation.
 9. Include operating key with each operating-key hose bibb.
 10. Include integral wall flange with each chrome- or nickel-plated hose bibb.
 11. Include backflow preventer for hose bibbs connected to chemical dispensers.

2.10 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
1. Equivalent to Watts Regulator Co. Series BD-QT.
 2. Pressure Rating: 150-psig minimum CWP.
 3. Size: 3/4".
 4. Body: Forged Brass.
 5. Ball: Chrome-plated brass.
 6. Stem Packing: Teflon.
 7. Handle: Aluminum or Vinyl-covered steel.
 8. Outlet: Threaded, short nipple with garden-hose thread and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. AMTROL, Inc.
 2. Josam Company.
 3. Sioux Chief Manufacturing Company, Inc.
 4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

5. Tyler Pipe; Wade Div.
 6. Watts Drainage Products.
 7. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
- B. Water-Hammer Arresters: Comply with ASSE 1010 or PDI-WH 201.
1. Type: Copper tube with piston.
 2. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 TRAP-SEAL PRIMER DEVICE – P-TRAP

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Precision Plumbing Products, Inc.
 2. Sioux Chief Manufacturing Company, Inc.
 3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- B. Basis of Design: Smith Prime-Eze Water Saver Trap Primer, model 2968.
- C. Supply-Type, Trap-Seal Primer Device: Chrome finish, with wall escutcheon, tail-piece and p-trap provided as required.

2.13 COMPRESSION OUTLET CONNECTION OUTLET BOX

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. IPS Corporation.
 2. Precision Plumbing Products.
 3. Sioux Chief Manufacturing Company, Inc.
 4. Oatey; MODA.
- B. Description: Ice maker outlet box with supply connections, valves, and water hammer arrester.
- C. Outlet Box:
1. Box: Single, Plastic.
 - a. Provide 2-hour fire rated box for installation in rated walls.
 2. Arresters: ASSE 1010, piston type.
 3. Mounting Brackets: Metal.
 4. Valves: Brass, quarter turn.
 5. Supply Outlet Connection: 1/4" compression.

2.14 POTABLE WATER EXPANSION TANKS

- A. Description: Steel, bladder-type, pressure-rated tank with cylindrical sidewalls.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Amtrol, Inc
 2. Taco
 3. Armstrong Pumps, Inc.
 4. Bell & Gossett Domestic Pump; a division of ITT Industries.
 5. Wilkins

6. Watts
 7. Aurora Pump; Pentair
 8. American Wheatley
- C. Welded steel, rated for 125-psig working pressure and 375°F maximum operating temperature, with taps in bottom of tank. Tanks shall be factory tested.
- D. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 °F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install water temperature-limiting devices on all public lavatories.
- D. Install water hammer arresters in piping branches with fast-closing valves, such as flush valves. Locate upstream of last fixture in pipe branch.
- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- F. Install piping adjacent to potable-water storage tanks to allow service and maintenance.
- G. Connect water piping to water heaters and storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.
- H. Drain Valves: 3/4" ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.
- I. If any device, fixture, or panel is required to be wall mounted by this contractor, provide AC Plywood, 3/4" or 5/8" thickness, painted both sides with fireproof paint, color to be determined and coordinated with owner. Paint is required even if installed on a non-fire rated wall.

3.2 EMERGENCY VALVE INSTALLATION

- A. Install check valves on inlets and outlets of tempering valves.
- B. See Specification Section 224000 Emergency Plumbing Fixture Installation for other

emergency mixing valve installation requirements.

3.3 POTABLE-WATER STORAGE TANK INSTALLATION

- A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.
 - 1. Install horizontal tanks on fabricated steel supports and saddles.
- B. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220510 "Common Work Results For Plumbing."
- C. Install the following devices on tanks as required:
 - 1. Pressure relief valves.
 - 2. Temperature and pressure relief valves.
 - 3. Vacuum relief valves.
 - 4. Tank vents on nonpressure tanks.
 - 5. Connections to accessories.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
- B. Test each pressure vacuum breaker, backflow preventer according to authorities having jurisdiction and the device's reference standard.

3.5 CLEANING

- A. Clean and disinfect potable-water storage tanks.
- B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in section 220500 "Plumbing General Provisions."

3.6 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Backwater valves.
2. Plug Valves.
3. Cleanouts.
4. Floor drains.
5. Flashing materials.
6. Sand/oil interceptors.
7. Sewage Ejectors.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 220500.
- B. Operation and Maintenance Data: For equipment covered in this section as per Section 220500.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable
1. Josam Company; Josam Div.
 2. MIFAB, Inc.
 3. Sioux Chief Manufacturing Company.
 4. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 5. Tyler Pipe; Wade Div.
 6. Watts Drainage Products Inc.
 7. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. All manufacturers are subject to compliance with requirements
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 BACKWATER VALVES

- A. Backwater Valves – Drain-Outlet: For vertical installation in bottom outlet of floor drain.
1. Basis of Design: Watts BV-1000.
 2. Size: Same as floor drain outlet.
 3. Body: Bronze compression plates, neoprene gasket.
 4. Check Valve: Removable ball float.
- B. Backwater Valve – In-Line, Plastic:
1. Basis of Design: Sioux Chief 869-4 series.
 2. Body: PVC, ABS; removable valve cover.
 3. Flapper: PVC.
 4. Flapper Gasket: Neoprene.

2.3 PLUG VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Henry Pratt Company.
 2. Milliken Valve Company.
 3. Val-Matic Valve & Manufacturing Corporation.
- B. Description: Non-lubricated, quarter turn, full port, eccentric type plug valve:
1. Basis of Design: Val-Matic Cam-Centric Plug Valve
 2. Standard: ANSI/AWWA C517.
 3. Body: ASTM A126 Class B cast iron.
 4. Seat: Minimum 90% nickel, welded in overlay.
 5. Plug: ASTM A536 ductile iron, Buna N or Nitrile seating surface.
 6. Bearings: Permanently lubricated 316 stainless steel.
 7. Actuator: Direct nut; grease packed, stops in open/close position; 2" nut.
 8. Accessories: T-handle to operate valve.

2.4 CLEANOUTS

- A. Standard: ASME A112.36.2M.
- B. Cleanouts – Exposed:
1. Body Material: As required to match connected piping.
 2. Size: Same as connected drain line as indicated on drawings.
 3. Closure: Countersunk or raised-head threaded plug.
 4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- C. Cleanout –Floor:
1. Basis of Design: Wade **6000 Series**.
 2. Cover – Finished Floor: Nickel bronze; scoriated; "C.O." cast into cover.
 3. Cover – Unfinished Floor: Cast iron; "C.O." cast into cover.
 4. Cover – Carpeted Floor: Same as finished floor cover with carpet **clamping flange**.
 5. Cover Shape: Round, except where noted otherwise on drawings.
 6. Type: Adjustable housing.
 7. Size: Same as connected drain line as indicated on drawings.
 8. Closure: Brass plug.
 9. Body or Ferrule: Cast iron in areas subjected to wheel traffic; Plastic permitted light duty areas.
 10. Top Loading Classification: Heavy duty in areas subjected to wheel traffic; Light duty otherwise.
 11. Riser: Long radius bends.
- D. Cleanouts – Wall:
1. Body: Soil pipe test tee, material as required to match connected piping.
 2. Size: Same as connected drain line as indicated on drawings.
 3. Closure: Raised-head, threaded plug.
 4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 5. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

Commented [cab1]: [6000 Series](#)

Commented [JN2]: Choose carpet clamping flange or carpet markers.

2.5 FLOOR DRAINS

A. Floor Drains:

1. Basis of Design: Watts FD-100
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain. Provide funnels where shown on drawings.
4. Body: Cast iron; provide seepage flange and clamping device.
5. Size: Same as connected drain line as indicated on drawings.
6. Strainer: Nickel bronze; adjustable; round, except as otherwise indicated on drawings.
7. Raised Flange: Provide for drains in mechanical rooms.
8. Loading Classification: Heavy duty in areas subjected to wheel traffic; Light duty otherwise.
9. Trap Features: Cleanout and trap-seal primer valve drain connection where shown on drawings.

B. General Requirements for Above Grade Drain Bodies:

1. Flashing Materials: Required.
2. Exception: Shower drains where flashing materials are furnished and installed by the General Contractor.
3. Dimensions: Minimum of 8" wider in all directions from drain body.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Sheet Membrane: Non-plasticized Chlorinated Polyethylene (CPE) conforming to ANSI A118.10.

1. General Use: 0.040-inch thickness.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

2.7 SAND/OIL INTERCEPTORS - POLYMER

A. Description: Polyethylene or fiberglass reinforced plastic oil and solids separator furnished for above or below grade installation with field adjustable riser system. Cover shall provide water/gas-tight seal and have a maximum load capacity appropriate for the install location.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Striem: OS Series.
2. Zurn: Proceptor.

C. Standard Features:

1. Risers: field adjusted for piping inverts.

2. Inlet and outlet diffusers: removable.

D. Accessories:

1. Oil level monitoring system.
 - a. NEMA 4X weatherproof enclosure.
 - b. 120v power connection.
 - c. Audible-visual indicator.
 - d. Dry contact for remote alarm.
 - i. Provide remote alarm panel.
2. Removable coalescing media.
3. Cover Capacity: Minimum 500 lbs load capacity.

2.8 SEWAGE EJECTOR

- A. Description: Submersible, fixed-position, dual mechanical seal pumps; factory-assembled and -tested pump unit.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 1. Weil Pump Company, Inc.
 2. Zoeller Company.
- C. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal pump.
 1. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 2. Impeller: Statically and dynamically balanced, cast iron or bronze design, non-clogging to pass 2" spherical solids, and keyed and secured to shaft.
 3. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
 4. Seal: Dual mechanical, seal leak detection probes.
- D. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
- E. Controls:
 1. Switch Type: Mechanical float or mercury-float type, and electric cables. (3) Floats total: Off, On, Alarm.
 2. Automatic Alternator: Start pumps on successive cycles and alarm if one cannot handle load.
 3. High-Water Alarm: Mechanical-float, or mercury-float control and electric bell; 120-V ac, with transformer and contacts for top mounted red beacon visual/audio alarm bell.
 4. Panel Accessories: Visible and audible high water alarm with dry auxiliary contacts, alarm test and silence switch, and pump run pilot lights.
 5. Remote Alarm Contacts: For remote alarm interface.
 - a. Provide remote alarm panel.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to 4". Use 4" CO for drainage piping up to 6" in size. Use 6" CO in larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each aggregate change in direction of piping greater than 135 degrees.
 - 3. Locate at minimum intervals of 75.
 - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Set grates of floor drains flush with finished floor, unless otherwise indicated.
 - 1. Size same as drainage piping.
 - 2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

3.2 GENERAL INTERCEPTOR INSTALLATION

- A. Sand/Oil Interceptor shall be furnished by this Contractor and turned over to the General Contractor for installation. This Contractor shall provide all piping and accessories.
- B. It is this Contractor's responsibility to field verify all piping inverts into and out of the interceptors to provide the correct extension/riser lengths to maintain the scheduled minimum solid and liquid capacities. Extension/riser lengths shall not result in reduced interceptor capacity.
- C. Unless otherwise noted, install cleanouts at the inlets and outlets of all interceptors.
- D. Install all interceptors with clear space for servicing.

3.3 EJECTOR SYSTEM INSTALLATION

- A. Provide isolation valves on all inlet piping and discharge piping to unit.
- B. Vent unit to exterior or plumbing vent stack.
- C. Fix unit to floor.
- D. Mount alarm where shown on Drawings, or in absence of location, coordinate with owner.
- E. Verify system operation by operating at least three start cycles with water.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris

and to prevent damage from traffic or construction work.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Water heaters.
 - 2. Recirculation pumps.
 - 3. Sump pumps.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 220500.
 - 1. Water Softeners Requirements:
 - a. Include wiring diagrams, rated capacities, operating characteristics, electrical characteristics, furnished specialties and accessories, plans, elevations, sections, details and connections to piping systems
- B. Operation and Maintenance Data: For equipment covered in this section as per Section 220500.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.
- C. Tank: ASME 'H' stamp for large water heaters.

1.4 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified period.
 - 1. Warranty Period: Not less than one year from the date of Substantial Completion.
- B. Burner and all heater components: 1 year parts only.
- C. Within the first year of operation, from the date of start-up, manufacturer will pay for all labor and freight, for any warranty issue.
 - 1. Manufacturers standard form in which manufacturer agrees to repair or replace components of water softener that fails in materials or workmanship within the specified warranty period.

PART 2 - PRODUCTS

2.1 WATER HEATERS, STORAGE TYPE

- A. Description: Residential, atmospheric vented, gas-fired, storage-type, domestic water heaters.
 - 1. Standard: ANSI Z21.10.1/CSA 4.1.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Bradford White Corporation.
 2. Rheem Manufacturing Company.
 3. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 4. State Water Heaters
 5. Lochinvar
- C. Storage-Tank Construction: Steel.
1. Pressure Rating: 150 psig.
 2. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- D. Factory-Installed Storage-Tank Appurtenances:
1. Anode Rod: Replaceable magnesium.
 2. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 3. Drain Valve: ASSE 1005.
 4. Insulation: Comply with ASHRAE/IESNA 90.1.
 5. Jacket: Steel with enameled finish.
 6. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 7. Burner: For use with atmospheric, gas-fired, water heaters and natural gas fuel.
 8. Automatic Ignition: Electric, automatic, gas-ignition system.
 9. Temperature Control: Adjustable thermostat.
 10. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
- E. Draft Hood: Low-profile-type draft diverter.
- F. Venting: See Specification Section 235000 "Central Heating Equipment" for venting materials and manufacturers.

2.2 WATER HEATER ACCESSORIES

- A. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater and include drain outlet not less than 3/4" with pipe threads or with garden-hose threads.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1
- C. Domestic-Water Heater Stands: Manufacturer's factory-fabricated or field fabricated steel stand for wall mounting, capable of supporting domestic-water heater and water.
- D. Gas Shutoff Valves: Refer to Section 220510 "Common Work Results for Plumbing". Furnish for installation in piping.

2.3 CIRCULATOR PUMPS, WET ROTOR

- A. Description: Factory-assembled and -tested, wet rotor, seal less, self-lubricating, cartridge pump designed for installation with pump mounted horizontally or vertically.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Armstrong Pumps Inc
 2. Bell & Gossett; Div. of ITT Industries
 3. Grundfos Pumps Corp.
 4. Taco Comfort Solutions.
 5. Thrush Company Inc.
 6. Wilo USA LLC
- C. Pump Construction:
1. Casing: Bronze with NPT, union, or flanged connections.
 2. Impeller: Non-metallic.
 3. Pump Shaft: Ceramic.
 4. Pump Bearings: Carbon.
- D. Motor: Single or multi-speed stainless steel replaceable cartridge design.
- E. Accessories:
1. Thermostats: Electric; adjustable for control of hot-water circulation pump.
 - a. Type: Water temperature sensor, minimum 65 to 200°F range.
 - b. Operation of Pump: On or off.
 - c. Settings: Start pump at 110 °F and stop pump at 120 °F.
 2. Timers: Electric; adjustable for control of hot-water circulation (recirc) pump.
 - a. Type: Programmable, 24 hour clock with manual override on-off switch.
 - b. Operation of Pump: On or off.
 - c. Programmable Sequence of Operation: Minimum of one on-off cycles each day.
 3. Electrical: 120/1/60; Pre-wired power cord, 6' in length, provide transformer if required.

2.4 SUBMERSIBLE SUMP PUMPS

- A. Description: Submersible, fixed-position, single-seal sump pumps; factory-assembled and -tested sump-pump unit.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Bell & Gossett Domestic Pump; ITT Corporation.
 2. Goulds Pumps; ITT Corporation.
 3. Grundfos Pumps Corp.
 4. Pentair Pump Group; Hydromatic Pumps.
 5. Little Giant Pump Co.
 6. Weil Pump Company, Inc.
 7. Zoeller Company.
- C. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump.
- D. Pump Construction:
1. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
 2. Impeller: Statically and dynamically balanced, cast iron or bronze design for clear wastewater handling, and keyed and secured to shaft.

3. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
 4. Seal: Mechanical.
- E. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
- F. Controls:
1. Enclosure: NEMA 250, Type 1.
 2. Switch Type: Mechanical float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, or mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
- G. Control-Interface Features:
1. Remote Alarm Contacts: For remote alarm interface.
 2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - a. On-off status of pump.
 - b. Alarm status.

2.5 SUMP-PUMP BASINS AND BASIN COVERS

- A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
1. Material: Polyethylene or fiberglass.
 2. Polyethylene Wall Thickness: Basin size 24"x30" or less: 0.20"; Basin size 36"x36" or less: 0.230".
 3. Fiberglass Wall Thickness: Basin size 36"x36" or less: 0.188"; Basin size 48"x48": 0.250".
 4. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
1. Reinforcement: Steel or cast iron, capable of supporting foot traffic.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. If any device, fixture, or panel is required to be wall mounted by this contractor, provide AC Plywood, 3/4" or 5/8" thickness, painted both sides with fireproof paint, color to be determined and coordinated with owner. Paint is required even if installed on a non-fire rated wall.

3.2 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
- B. Residential, Water Heater Mounting: Install residential, water heaters on floor, or on water-heater stand on floor if required to be elevated 18".
- C. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances.
 - 1. Install shutoff valves on water-supply piping to water heaters and on hot-water outlet piping.
- D. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired water heaters.
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install condensate drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install combination temperature-and-pressure relief valves in water piping for water heaters without storage. Extend water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- H. Install thermometers on outlet piping of commercial water heaters.
- I. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig.
- J. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221100 "Plumbing Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of water heaters.
- C. Install piping adjacent to potable-water storage tanks to allow service and maintenance.
- D. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.
 - 1. Isolation valves: Ball.
 - 2. Drain Valves: 3/4" ball valve. Include outlet with, or nipple in outlet with threads for garden-hose service, threaded cap, and chain.

3.4 CLEANING

- A. Clean and disinfect potable-water storage tanks.
- B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in section 220500 “Plumbing General Provisions.”

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Water closets.
 - 2. Toilet seats.
 - 3. Lavatories.
 - 4. Lavatory faucets.
 - 5. Sinks.
 - 6. Laundry/utility tubs.
 - 7. Wall faucets.
 - 8. Electric water coolers.
 - 9. Freeze-proof hydrants.
 - 10. Emergency shower/eye wash.
 - 11. Supply fittings.
 - 12. Protective shielding pipe covers.
- B. See Drawings for basis of design manufacturers and models.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 220500.
- B. Operation and Maintenance Data: For equipment covered in this section as per Section 220500.

1.3 QUALITY ASSURANCE

- A. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- B. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
 - 1. Water closet, lavatory:
 - a. American Standard America.
 - b. Crane Plumbing.
 - c. Kohler Co.
 - d. Mansfield Plumbing.
 - e. Sloan Valve Company.
 - f. Toto USA, Inc.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Toilet seats:
 - a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corporation.

- c. Church Seats.
 - d. Kohler Co.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
3. Brassware (faucets and freeze-proof hydrants) :
- a. American Standard.
 - b. Cambridge Brass, Inc.
 - c. Chicago Faucets.
 - d. Component Hardware Group, Inc.
 - e. Delta Faucet Company.
 - f. Elkay Manufacturing Co.
 - g. Grohe America, Inc.
 - h. Just Manufacturing.
 - i. Kohler Co.
 - j. Moen Incorporated.
 - k. Sloan Valve Company.
 - l. T & S Brass and Bronze Works, Inc.
 - m. Zurn Industries, LLC; Commercial Brass and Fixtures.
4. Sinks:
- a. Elkay Manufacturing Co.
 - b. Just Manufacturing.
 - c. Franke Kindred Canada.
5. Laundry/Utility Tub:
- a. Ferguson Enterprises, Inc.; ProFlo Brand.
 - b. Fiat Products.
 - c. Florestone Products Co., Inc.
 - d. Mustee, E. L., & Sons, Inc.
 - e. Swan Corporation (The).
 - f. Zurn Industries, LLC; Light Commercial Specialty Plumbing Products.
6. Water Coolers:
- a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
 - d. Oasis International.
 - e. Tri Palm International, LLC; Oasis Brand.
7. Freeze-Proof Hydrants:
- a. Josam Company.
 - b. Wade Specification Drainage Products.
 - c. Watts Water Technologies.
 - d. Woodford Manufacturing Company.
 - e. Zurn Industries, LLC.
8. Emergency Fixtures:
- a. Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Encon Safety Products.
 - e. Guardian Equipment Co.
 - f. Haws Corporation.

- g. Speakman Company.
 - h. Stingray Systems.
- 9. Carriers:
 - a. Jay R. Smith MFG. Co., Inc.
 - b. Josam Company.
 - c. Wade Specification Drainage Products.
 - d. Watts Water Technologies.
 - e. Zurn Industries, LLC.
- B. All manufacturers are subject to compliance with requirements.
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 WATER CLOSETS – FLUSH TANK

- A. Water Closets: Floor mounted, floor outlet, two-piece, close coupled (gravity tank).
 - 1. ADA Water Closets: Comply with ICC/ANSI A117.1
- B. Bowl:
 - 1. Material: Vitreous china, white, conforming to ASME A112.19.2/CSA B45.1.
 - 2. Bowl Type: Siphon jet.
 - 3. Rim Contour: Elongated.
- C. Tank:
 - 1. Material: Vitreous china, white, conforming to ASME A112.19.2/CSA B45.1.
 - 2. Flushing: Gravity flush.
 - 3. Trip Lever: Polished Chrome.
- D. Toilet Seat: Required.

2.3 TOILET SEATS

- A. Provide on all water closets:
 - 1. Standard: IAPMO/ANSI Z124.5.
 - 2. Material: Plastic, white.
 - 3. Type: Commercial (Standard).
 - 4. Shape: Elongated rim, open front.
 - 5. Hinge: Check, non-corroding metal.
 - 6. Seat Cover: Not required.

2.4 LAVATORIES – WALL-MOUNTED

- A. Description: Vitreous china, wall mounted, with back; ADA compliant.
 - 1. Material: Vitreous china, white, conforming to ASME A112.19.2/CSA B45.1.
 - 2. Faucet-Hole Location: Top.
 - 3. Soap Dispenser Hole: None.
 - 4. Overflow: Required.
 - 5. Mounting: Concealed-arm chair carrier.
 - 6. ADA Standard: Comply with ICC/ANSI A117.1
- B. Accessories: Supplies, p-trap, support.

1. Supplies: 3/8" angle with stops.
2. P-trap: 1-1/4", 17 gauge, chrome plated.
3. Support for 2x4 stud wall: Carrier equivalent to Wade 404 series.
4. Support for plumbing chase wall (2x6 or greater): Concealed-arm lavatory carrier equivalent to Wade 520 series.

2.5 LAVATORY FAUCETS – MANUAL PEDESTAL

- A. Description: Manual, single-handle mixing, commercial general-duty, solid-brass valve.
1. Standard: ASME A112.18.1/CSA B125.1.
 2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punching.
 3. Body Material: Solid brass.
 - a. Finish: Polished chrome plate.
 4. Spout: Fixed.
 5. Spout Outlet: Vandal resistant aerator.
 6. Lavatory Outlet: Grid strainer with tailpiece.

2.6 LAVATORY FAUCETS – SENSOR GOOSENECK

- A. Description: Automatic, sensor activated, gooseneck, ADA compliant, hard-wired.
1. Standard: ASME A112.18.1/CSA B125.1, and ICC/ANSI A117.1.
 2. General: Vandal resistant; coordinate faucet inlet with fixture hole punching.
 3. Body Material: Solid brass.
 - a. Finish: Polished chrome plate.
 4. Spout: Gooseneck, swivel, 4-1/4" spout reach.
 5. Spout Outlet: Laminar flow.
 6. Valve: Filtered solenoid.
 7. Lavatory Outlet: Grid strainer with tailpiece.
- B. Accessories:
1. Transformer: 120/1/60 primary, Class II, UL listed.
 - a. Provide transformers to support multiple faucets as applicable.
 - b. Connections: Box mount, hard-wired.
 - c. Individual Plug-in Style Transformers: MC is responsible for the low-voltage wiring between the plug-in transformer and the sensor.
 2. Thermostatic Mixing Valve: Comply with ASSE 1070.
 - a. Not required where master mixing valve is provided.

2.7 SINKS – HAND WASH

- A. Description: Wall mounted, inverted edge on rim.
1. Standard: ASME A112.19.3/CSA B45.4.
 2. Material: Enameled cast iron.
 3. Drain: Grid with 1-1/2" tailpiece and p-trap; removable conical basket strainer with metal stem and rubber stopper, equivalent to Elkay model LK35.
 4. Drain Location: Centered in compartment.
 5. Mounting: Wall hung.

2.8 LAUNDRY/UTILITY TUB

- A. Description: One piece, molded tub on four legs, with faucet and accessories.
1. Standard: IAPMO/ANSI Z124.6.
 2. Tub Material: White structural polymer, minimum 18 gallon capacity.
 3. Leg Material: White enamel coated steel angle legs with leveling devices.
 4. Drain: Integrally molded, supply stopper and tail piece nut with washer.
 5. Faucet: Deck mounted, chrome plated, 2-3/8" lever handles, 6" swing double-bend spout with aerator and hose adaptor.
 6. Accessories: Overflow tube.

2.9 WALL FAUCET

- A. Description: Wall mounted, hot and cold faucet with wall brace and pail-hook.
1. Standard: ASME A112.18.1/CSA B125.1.
 2. General: Include hot- and cold-water indicators.
 - a. Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Check Stops: Provide on hot and cold water.
 3. Mounting Type: Back/wall, exposed.
 4. Valve Handle(s):
 - a. Non-ADA: 2-inch lever.
 - b. ADA Compliant: 6-inch elbow blades.
 5. Spout: Rigid.
 - a. Vacuum Breaker: Required for hose outlet.
 - b. Spout Outlet: 3/4" hose thread.

2.10 ELECTRIC WATER COOLERS WITH BOTTLE FILLER

- A. Description: Self-contained, ADA compliant, wall hung electric refrigerated water cooler and filtered bottle filling station.
- B. Water Cooler Cabinet: Bi-level with two attached cabinets, vinyl-covered steel with stainless-steel top.
1. Drain: Grid with 1-1/4" tailpiece with p-trap.
 2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 3. Control: Push bar.
 4. Mounting: Flush to wall.
- C. Bottle Filling Station: Touchless activation with auto timed shut-off, LED filter replacement indicator.
1. Filtration System: 3000-gallon capacity, for taste, odor, lead, chlorine reduction.
 2. Materials: Stainless steel with ABS alcove.
 3. Extra Filters: Provide 3 additional sets.
- D. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
1. Electrical: 120/1/60.

2. Minimum Capacity: 7 gph.

2.11 FREEZE-PROOF HYDRANTS

- A. Description: Concealed, self-draining, non-freeze wall hydrants.
 1. Operation: Loose key, include one with each hydrant.
 2. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 3. Outlet: Concealed, garden-hose thread.
 4. Box: Flush mounted with cover, with rough bronze finish.
 5. Nozzle and Wall-Plate Finish: Flush mounted, with chrome finish.
 6. Mounting Height: 2 feet above finished grade unless otherwise noted.

2.12 FREEZE-PROOF HYDRANTS

- A. Description: Exposed, non-freeze wall hydrants.
 1. Operation: Loose key.
 2. Casing and Operating Rod: Of length required to match wall thickness.
 3. Outlet: Exposed, garden-hose thread, integral vacuum breaker.
 4. Mounting Height: 2 feet above finished grade unless otherwise noted.

2.13 EMERGENCY EYEWASH

- A. Description: Plumbed eye- and face-wash unit with mixing valve.
- B. Standards: ANSI Z358.1, ASSE 1071.
- C. Emergency eye/face wash:
 1. Capacity: Not less than 3 gpm for at least 15 minutes.
 2. Supply Piping: 1/2" with stay-open control valve.
 3. Control-Valve Actuator: Paddle.
 4. Spray-Head Assembly: Two receptor-mounted spray heads with flip covers.
 5. Receptor: Stainless-steel or ABS bowl.
 6. Drain Piping: Chrome-plated, receptor drain, P-trap, waste to wall, and wall flange.
- D. Include: Universal emergency sign.
- E. Tempering valve: Emergency eyewash thermostatic mixing valve.
 1. Basis of Design: Lawler 911E/F.
 2. See Specification Section 221200 "Plumbing Specialties" for mixing valve requirements.

2.14 PROTECTIVE SHIELDING PIPE COVERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following or prior approved:
 1. Engineered Brass Company.
 2. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 3. McGuire Manufacturing.
 4. Plumberex.
 5. Truebro; a brand of IPS Corporation.
 6. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

- B. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- C. Alternative: Contractor manufactured 18 gauge rolled stainless steel with flanges and mounting hardware. Dimensions to comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General Installation:
 - 1. Install fixture supports firmly attached to building structure.
 - 2. Install fixtures level, plumb, and in accordance with manufacturer's rough-in instructions and height requirements of authorities having jurisdiction.
- B. Wall Flange and Escutcheon Installation:
 - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- C. Joint Sealing:
 - 1. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - 2. Match sealant color to fixture color.
- D. Install toilet seats on water closets.
- E. Lavatory Installation:
 - 1. Install water temperature limiting devices on all public lavatories.
 - 2. Install supports, affixed to building substrate, for wall-mounted lavatories.
- F. Sink Installation:
 - 1. Install supports, affixed to building substrate, for wall-hung sinks.
 - 2. Install water-supply piping with stop on each supply to each sink faucet in locations where they can be easily reached for operation.
- G. Shielding Installation:
 - 1. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks and lavatories.
- H. Water Cooler Installation
 - 1. For fixtures indicated for children, install at height required by authorities having jurisdiction.
 - 2. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
 - 3. Install water-supply piping with shutoff ball valve on supply to each fixture to be connected to domestic-water distribution piping. Install valves in locations where they can be easily reached for operation.
 - 4. Where a bottle filler is installed in a stand-alone application in a staff break room or

other, coordinate the height and location of the fixture to ensure it does not interfere with cabinet door swings or drawer opening distances.

I. Emergency Plumbing Fixture Installation

1. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
2. Install shutoff ball valves in water-supply piping to fixtures. Install valves in locations where they can easily be reached for operation.
 - a. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
3. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals.
4. Install thermometers in supply and outlet piping connections to water-tempering equipment.

3.2 CONNECTION SCHEDULE

- A. Unless otherwise indicated on the Plans, rough-in sizes for waste, vent and supply connections shall be as follows:

	Waste	Vent	Supply
1. Water Closets – Flush Tank:	3"	2"	1/2"
2. Lavatories	1-1/2"	1-1/2"	1/2"
3. Service Sinks	3"	1-1/2"	3/4"
4. Hose Bibbs/Wall Faucets	3"	1-1/2"	3/4"
5. Sinks	2"	1-1/2"	1/2"
6. Electric Water Coolers	1-1/2"	1-1/2"	1/2"

3.3 ADJUSTING

- A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at bubblers, faucets and flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- D. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Adjust set point within allowable temperature range.

3.4 CLEANING AND PROTECTION

- A. Clean fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Do not allow use of fixtures after final cleaning for temporary facilities unless approved by Owner.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Specification Format

1. These Specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractors, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "the Contractor shall", and "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, perform all indicated requirements whether stated imperatively or otherwise.
2. Three Part Format
 - a. "Part 1 - General": Covers those areas which relate to the Work, and which define the general administrative and technical requirements specific to a particular section.
 - b. "Part 2 - Products": Defines, in detail, the acceptance equipment and materials to be incorporated into the Work.
 - c. "Part 3 - Execution": Describes, in detail, the manner in which items covered by Part 2 are to be incorporated into the Work.
3. Where Codes, Specifications and Drawings are in conflict, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies immediately to the Engineer prior to commencing related work.

B. Definitions:

1. Furnish: Supply equipment as required by these Drawings and Specifications, delivered to the job site for installation or use by others.
2. Install: Fix in position for total operational use all apparatus as shown, specified or required. Provide all miscellaneous fittings and wiring supplies.
3. Or Approved Equal: Equipment or materials selected by Contractor subject to Engineer's acceptance.
4. Or Equivalent: Equipment or materials selected by Contractor matching the function and performance of equipment or materials listed.
5. Provide: Furnish and install in place, total and operational.
6. Complete/Completely: All pipes, fittings, ducts, wiring supplies, and accessories provided for the noted equipment from the equipment to the mains or noted termination points.

1.2 SCOPE OF WORK

- A. The work covered by this Division consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of the HVAC systems, in strict accordance with Division 23 of this Specification and applicable Drawings and subject to the terms and conditions of the Contract.
- B. Work of this Division is subject to requirements of Instructions to Bidders, General Conditions, Supplementary Conditions, Division One, and all other sections of this Specification.

- C. Examine site and all Contract documents prior to submittal of bid.
 - 1. Submittal of a Bid shall indicate the Contractor has examined the Site and Drawings and has included all required allowances in this Bid. No allowance shall be made for errors resulting from the Contractor's failure to visit job sites and to review Drawings.
- D. Division 23 Work: Includes, but is not limited to, providing the following:
 - 1. Direct Expansion (DX) System: Piping and equipment.
 - 2. Air Distribution System: Equipment and ductwork.
 - 3. Ventilation and Exhaust System: Equipment and ductwork.
 - 4. Insulation System: Ductwork and piping.

1.3 ALTERNATES

- A. Refer to Division 1 for alternates.

1.4 CONTINGENCY

- A. Refer to Division 01 for amount to include in Mechanical Bid.

1.5 SUBMITTALS

- A. General:
 - 1. Preferred Submittal Format: PDF, unless otherwise noted.
 - 2. Preferred Submittal Nomenclature: Unless otherwise noted, PDF submittals are to be named according to the following:
 - a. [Specification Section Number] – [Specification Name or Equipment Included]
 - 3. Distribution: Unless otherwise noted, direct all correspondence concerning Division 23 submittals to:

Justin Byrne
PRAIRIE ENGINEERING, P.C.
1905 17TH STREET SE
MINOT, ND 58701
jbyrne@prairieengineeringpc.com

- B. Substitution and Prior Approval to Quote:
 - 1. Format and Content: Complete descriptive technical data on the proposed item consisting of model numbers, type, size and performance characteristics.
 - 2. Submission Timing: Minimum of 192 hours (eight days) prior to bid opening.
 - a. Substitutions will not be permitted after bid opening except where such substitution is considered by the Engineer to be in the best interest of the Owner.
 - 3. Bidder Notification: Prior to bid opening via Addenda, sent to all planholders.
 - 4. Contractor Responsibility: This contractor will be responsible for all coordination, construction costs, and Architectural/Engineering design fees required to substitute equipment that has different characteristics than designed including weights, physical dimensions, clearances, mechanical characteristics, electrical characteristics, and other characteristics deemed important to the design by the Architect/Engineer.
 - 5. Alternative Format: Printed paper, two copies; Self-addressed, stamped envelope required for return reply.

C. Schedule of Values

1. Distribution: One copy to Engineer.
2. Format and Content: When included with the Bid, at minimum the following categories shall be indicated:
 - a. "Project mobilization"
 - b. "Start-up and Commissioning"
 - c. "Excavation and Backfill"
 - d. "Insulation"
 - e. "Piping Systems" (all piping, valves, fittings, hangers, installed in place)
 - f. "Sheet Metal" (all ductwork, lining, dampers, hangers, installed in place)
 - g. "Terminal Units" (unit heaters, grilles, diffusers, radiation, installed in place)
 - h. "Air Distribution Equipment" (all fans, VAVs, installed in place)
3. Submission Timing: Prior to first payment application.

D. Shop Drawings

1. Distribution: Engineer via the Prime Contractor for each item indicated.
2. Format and Content: Include catalog numbers, performance data, dimensions and other descriptive information.
 - a. Contractor Review: Dated and signed cover sheet or review stamp for each Shop Drawing file to indicate thorough review. **Email message text not acceptable.**
 - b. Submit a separate shop drawing file for each Specification Section including only the items within that Section.
 - c. Non-Conforming: Returned to Contractor without review.
3. Submission Timing: Prior to delivery of materials to job site.

E. Record Drawings

1. Format and Content: Paper copy of Drawings project site.
 - a. As work progresses, Contractor's field supervisor shall mark Record Drawings in red pencil to indicate actual conditions of installation.
 - b. Give particular attention to marking actual locations of underground piping.
 - c. Affix all addendum and change order descriptions to appropriate record drawing sheet, utilizing spray adhesive.
 - d. Make Record Drawings available to Engineer during project visitation.
2. Submission Timing: Close of project with Record Manuals.

F. Spare Equipment and Devices

1. Distribution: Owner.
2. Format and Content: List quantities on contractor letterhead or invoice, obtain signature of Owner's representative acknowledging receipt, and include with each Record Manual.
3. Submission Timing: Close of project with Record Manuals.

G. Operation and Maintenance Manuals

1. Submission Timing: Close of project, as condition of its acceptance.
2. Record Manual information shall be included for all equipment/material where Shop Drawings are required.
3. Format and Content: Two copies, Loose-leaf hardcover binders, **and** in PDF format on CDs or USB drive.

- a. List project name, date, Contractor's name, address and telephone number on exterior label of each Record Manual and CD.
- b. Include an index sheet indicating subcontractor and subcontractor's phone number and each major piece of equipment, supplier and supplier's telephone number. Provide tabbed dividers indicating major groupings of equipment.
- c. Include a copy of the Shop Drawings.
- d. Include all installation, operation and maintenance data packaged with any equipment.
- e. Include all signed and dated final punch lists from walkthroughs performed by the Engineer.

1.6 APPLICATIONS FOR PAYMENT

- A. Refer to Division 1 "Applications for Payment".
- B. Provide one additional copy, sent directly to the Engineer.
- C. Schedule of Values: At minimum, include items in Submittal article.

1.7 CHANGES TO CONTRACT

- A. Any required changes to the contract after bid date shall be in accordance with General Conditions/Division 1 and this section. Where any discrepancies between the sections are encountered, the more restrictive section shall apply.
- B. Proposed changes shall be accompanied with complete substantiating documentation.
 1. Provide an itemized list of quantities for materials, equipment, and supplies.
 - a. Include unit costs for each item and extended price.
 - b. Include unit labor for each item and extended time.
 2. Provide subcontractor proposals that include the same substantiating documentation.
 3. Provide quotations from suppliers for any specially ordered equipment.
- C. Material costs shall be actual costs to the contractor, obtaining the materials through normal supply channels, including trade and quantity discounts. Utilizing "suggested pricing" from national pricing organizations for unit costs shall not be accepted. Upon request, the contractor or subcontractor shall submit evidence to substantiate the costs.
- D. Labor units shall be industry accepted standard labor hours to perform one unit of work. If the work is being performed in a location that is not considered to be standard working conditions for that specific task, additional labor shall be itemized.
- E. Labor rates shall be the actual rate paid for the workman category along with associated labor burden. Labor burden shall consist only of the mandatory fringe benefits, labor taxes, and labor insurances as affected by payroll. The owner reserves the right to reject any labor burden which is inconsistent with other similar contractors or where the fringe benefit cost is in excess of established labor agreements.
- F. Allowable markups for contractor and subcontractors:
 1. Overhead on work performed by own forces: 12% maximum.
 2. Profit on work performed by own forces: 10% maximum.
 3. Commission on work performed by Subcontractors: 5% maximum.
 4. Sales tax.
 5. Bond and permit increases where applicable.

6. No additional markups shall be allowed for:
 - a. Field and/or office supervision/administration time.
 - b. Tool burden.
 - c. Shop burden.
 - d. Overhead/Profit applied to work performed by others.
- G. Additional costs for travel and subsistence shall only be allowed if the proposal includes a request for extension of the completion date. Furthermore, those costs shall be proportional to the number of working days of the extension.
- H. Subcontractors shall compute their costs in the same manner as the contractor. Subcontractors are subject to the same markup constraints as described herein.
- I. For changes resulting in credit to the costs, no restocking fees for materials shall be applied by the contractor or subcontractors.

1.8 QUALITY ASSURANCE

- A. Qualifications of Installers
 1. For installation and testing, use only trained licensed and experienced workmen familiar with items required and manufacturer's recommended methods.
 2. In acceptance or rejection of installed work, no allowance will be made for lack of skill on the part of the workmen.
 3. Medical Gas Piping Installers shall be certified as Class One Installers and provide proof of certification enclosed within their bid form packet.

1.9 AUTHORITIES AND AGENCIES

- A. Materials, workmanship and installation: comply with the latest editions of all applicable codes, local ordinances, industry standards, utility company regulations, insurance carrier requirements and these Specifications.
- B. Obtain and pay all permits, inspections, licenses and other charges pertaining to the Work. Upon completion of the Work, furnish proof of acceptance by proper agency having jurisdiction.
- C. Codes and standards shall include, but not necessarily be limited to, the following:
 1. International Energy Conservation Code (IECC);
 2. Uniform Plumbing Code;
 3. North Dakota State Building Code;
 4. International Building Code (IBC);
 5. International Mechanical Code (IMC);
 6. International Fuel Gas Code (IFC);
 7. National Fire Protection Association (NFPA) – Sections as adopted by authority having jurisdiction.
- D. The more stringent provisions shall govern where provisions of pertinent codes and standards conflict with these Specifications or Drawings. Where Codes, Specifications or Drawings differ with one another, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies to the Engineer immediately.
 1. Pertinent codes and standards shall not be cited to furnish less than specifically shown or specified.

2. Meeting the minimum standards of the above Codes does not permit a lower grade of construction where Plans or Specifications call for workmanship or materials in excess of Code Requirements.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 GUARANTEE AND WARRANTY

- A. Except where otherwise noted, contractor shall guarantee materials, workmanship and the proper operation of equipment for a period of one year after Owner's beneficial use of the building or mechanical system. Contractor shall correct all equipment, material and workmanship found to be defective or non-conforming to the contract documents without cost to Owner during that one year period.
- B. Guarantee shall include trips to the project site by Contractor to adjust mechanical equipment as required, ensuring it is operating as intended.
- C. Specified guarantee shall not relieve Contractor from liability arising from improper installation or non-compliance with applicable codes.

1.11 TEMPORARY FACILITIES

- A. Refer to Special Conditions and/or Division 1 for details of temporary facilities.

1.12 NOMENCLATURE

- A. Pipe sizes listed are nominal pipe sizes throughout this Division except where otherwise noted.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Material and equipment shall be as shown or specified. Provide material not specifically described but required for a complete and proper installation of the Work, subject to the acceptance of the Engineer.
- B. Owner will not be liable for material installed in non-compliance with codes, standards, and these Contract Documents.
- C. Fire Stop System material shall be by 3M "Fire Barrier", Metacaulk, Hilti, Nelson Firestop Products, or AD Fire. See Division 07 for further details on approved materials.

2.2 ELECTRIC WIRING

- A. The Division 23 Contractor shall furnish all motors, special controls and electrical devices as specified herein for proper operation of the equipment furnished.
- B. Division 26 Contractor shall furnish and install, as required, disconnects, starters, switches, etc., and do all necessary power and control wiring including the installation of electrical devices such as thermostats, humidistats, remote control panels, etc., furnished separately by Division 23 Contractor, unless otherwise noted in Equipment Specifications or noted in Section 230900.

PART 3 - EXECUTION

3.1 GENERAL

- A. Engineer, Architect, or Owner shall not be responsible for the means, methods, techniques, sequences or procedures of construction selected by Contractor.
- B. Engineer, Architect, or Owner shall not be responsible for safety precautions and programs incidental to work of Contractor.
- C. It is the sole responsibility of Contractor to initiate, maintain, and supervise all safety precautions and programs in connection with the Work.
- D. In general, it is intended that ductwork and piping be installed parallel to building lines, unless otherwise shown on the Drawings, and that equipment be located symmetrical with the architectural elements of the building.

3.2 SURFACE CONDITIONS

- A. Prior to work of each Section of Division 23, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that work of this Division may be installed in accordance with all pertinent codes, regulations and standards.

3.3 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Division before, during and after installation and to protect the installed work and materials of all other trades.
- B. Plugs: Install in ends of uncompleted piping at end of each day or when work stops.
- C. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

3.4 COORDINATION

- A. Order equipment and material in a timely fashion to assure it is on the job site when required.
- B. Coordinate installation of material with schedule of other trades to prevent unnecessary delay in construction schedule.
- C. Division 23 piping, duct and equipment installations shall comply with National Electrical Code requirements 110.26 "working spaces" and "dedicated spaces". Mechanical ducts and pipes shall not be installed in the space near electrical panels/equipment defined as "working spaces" or "dedicated spaces".

3.5 DISCREPANCIES, CONSTRUCTION CONFLICTS AND DRAWINGS

- A. Discrepancies
 - 1. Prior to submitting bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification.
 - 2. The Architect, Engineer or Owner will not be responsible for any oral instructions or modifications to the contract documents prior to opening of bids.
 - 3. Written interpretation or clarification will be made by Addenda.
- B. Construction Conflicts

1. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision.
2. Do not proceed with installation in area of question until conflict has been fully resolved.
3. When so directed by Engineer, Contractor shall make minor adjustment to avoid interferences with other trades. Such minor adjustments shall be performed at no additional cost to the Architect, Engineer or Owner.

C. Drawings

1. Drawings indicate extent and general layout of mechanical systems for project. Due to small scale, it is not possible to indicate all fittings and accessories that may be required. Provide such fittings and accessories as required to form a complete and operating system in general conformance with Specifications and Drawings.
2. Exact locations, distances, levels and other conditions will be governed by the structure. Field measurements shall take precedence over the Drawings. Use the Drawings and these Specifications for guidance. Secure the Architect's approval for all changes in locations.
3. Verify all measurements at site. No compensation will be made because of difference between locations shown on the Drawings and measurements at the building.
4. Refer to the architectural drawings for dimensions and locations of walls, partitions, doors, windows, ceiling heights, door swings and other details of construction.

3.6 OFFSETS

- A. Where required to allow clearance of electrical conduit and outlet boxes, beams, etc., to avoid interference with work of other trades, to increase head room under mechanical systems or to improve the appearance of mechanical systems work, this Contractor shall offset his mechanical system as directed by the Architect/Engineer.

3.7 CUTTING AND PATCHING

- A. Refer to General Conditions. Unless specifically called out to be performed by other Contractors, the Division 23 Contractor shall perform all cutting and patching required for the installation of material and equipment furnished under his Contract.
- B. Opening/holes cut to allow passage of ducts and pipes through concrete floor shall be patched by the Contractor doing the cutting unless indicated otherwise on the Drawings.
- C. Fire-Barrier Penetrations
1. Pipe penetrations through fire rated walls and floors shall be sealed with a UL classified Fire Stop System. Fire Stops shall be provided in accordance with the appropriate System No. as it relates to pipe size/Material and wall or floor rating/material.
 2. See Specification Section 230510 for other Fire-Barrier Penetration requirements.
 3. See Section 2 article "Materials" of this Specification for approved fire stop system material.
- D. Openings between ductwork and fire rated walls and floors shall be sealed with fire rated caulking or steel collars on both sides of wall or floor.
- E. Restore damaged surfaces to their original condition by skilled mechanics of the trade involved. Contractor at fault shall assume all cost.
- F. Use only rotary type drilling tools to cut concrete.

- G. Do not endanger the stability of the structure. Do not at any time cut or alter work of any other Contractor without Architect's consent.

3.8 FIELD QUALITY CONTROL

- A. Perform field tests and inspections. Test new piping and parts of existing piping that have been altered, extended, or repaired.
- B. Gas Piping Tests:
 - 1. Test gas piping as required by the Authority Having Jurisdiction or the Utility Company.
 - 2. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- C. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained. Piping will be considered defective if it does not pass tests and inspections.

3.9 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.10 CLEANING

- A. Clean interior of duct and piping systems. Remove dirt and debris as work progresses.

3.11 INSTRUCTIONS

- A. Provide written and oral operating and maintenance instructions to Owner's representatives. The oral instructions shall be given before the Owner occupies the buildings. Instructions to include **all** building's mechanical systems and equipment.
- B. Copies of written operating and maintenance instructions shall be included with each Record Manual.
- C. Division 23 Contractor shall coordinate with Owner at Owner's convenience, formal instruction time for contractor personnel to instruct Owner's Representatives on all equipment. Provide similar equipment supplier's instructions where specified thus.
- D. Formal instructions shall be video recorded when required by other Sections of this Specification by this Contractor. Format shall be DVD. Formal instruction to be included with each Record Manual, being referenced to and a part of the Manual.

3.12 CLEAN UP

- A. Each Contractor shall be responsible for cleaning up after his work, including the removal of all scrap material left on the job by his men or Subcontractors. This will include the removal of all pipe and sheet metal cuttings, pieces of sheet metal, pipe, and insulation and other debris.

- B. Clean all heating units, clean and straighten fins on all coils, clean scale, dirt or debris off piping, motors, etc., oil or grease all motors, fan bearings, pump gear boxes, etc., and leave in a clean best possible working condition. Install clean filters in ventilation system prior to turning job over to Owner.
- C. After all tests have been made and the mechanical systems are operating properly, this Contractor shall go over the entire system and remove labels from all mechanical equipment.
- D. All equipment having finished paint surfaces shall be examined upon completion for scratches and other damage. Touch up all surfaces as required with paint of color to match factory finish.
- E. Perform all cleaning as required by other Sections of Division 23.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Ball valves.
 - 2. Flexible Connectors.
 - 3. Hangers.
 - 4. Sleeves.
 - 5. Sleeve-seal systems.
 - 6. Escutcheons.
 - 7. Equipment and Warning labels.
 - 8. Roof curbs.
 - 9. Pipe labels.
 - 10. Thermostats.
 - 11. Fire Barrier Penetrations
- B. Nomenclature:
 - 1. SWP: Steam working pressure.
 - 2. CWP: Cold working pressure.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Product Data: Each type of valve, gauge, strainer, sleeve, and sleeve-seal system.
 - 2. Fire-Barrier Penetrations: UL Classified System, System Number.
- B. Operation and Maintenance Data: To include in operation and maintenance manuals as per Section 230500.

PART 2 - PRODUCTS

2.1 VALVE MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
 - 1. Anvil International.
 - 2. Conbraco Industries, Inc.; Apollo Valves.
 - 3. Milwaukee Valve Company.
 - 4. Nexus Valve.
 - 5. NIBCO INC.
 - 6. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- B. All manufacturers are subject to compliance with requirements
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

2.3 BALL VALVES

A. Two-Piece, Metal, Ball Valves:

1. Basis of Design: Apollo Valves 70-100 Series.
2. Standard and Rating: MSS SP-110; 150 psi SWP, 600 psi CWP at 500°F.
3. Body Design: Two piece, forged brass or bronze; PTFE or TFE seats.
4. Stem: Brass or Bronze, blowout-proof, packing nut.
5. Ball: Chrome-plated brass, full or regular port.
6. Operator: Lever; separate lever nut.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Flexicraft Industries.
2. Keflex; Flex-Weld Incorporated.
3. Mason-Mercer.
4. Metraflex Company.
5. Minnesota Flexible Corp. (MFC).
6. Thermo Tech Inc.
7. Twin City Hose.

B. Body: Stainless-steel bellows with woven, flexible, stainless steel or bronze, wire-reinforcing protective jacket rated for 150 psig maximum operating pressure and 250 °F maximum operating temperature.

C. End Connections: Threaded or flanged to match equipment connected.

D. Performance: Capable of 3/4-inch misalignment.

2.5 PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Clevis type with locknut to threaded extension rod, factory-fabricated components; MSS SP-58 types 1 through 58.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or cadmium plated steel.

B. Copper Pipe Hangers:

1. Description: Clevis type with locknut to threaded extension rod, copper-coated-steel, factory-fabricated components; MSS SP-58 types 1 through 58.

- 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
- C. Trapeze Pipe Hangers:
 - 1. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.
- D. Plastic Pipe Support Channel
 - 1. Description: 18 Ga. steel v-channel; standard finish.

2.6 DUCT HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: 1", 16 gauge straps; 3/8" rod.
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

2.9 SLEEVES

- A. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- B. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

2.10 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Metraflex Company (The).
 - 2. Link-Seal; Pipeline Seal & Insulator, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Glass reinforced plastic.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.11 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

2.12 EQUIPMENT AND WARNING LABELS

A. General Requirements

1. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1-1/4 inch.
2. Minimum Letter Size: 1 inch for name of units. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
3. Fasteners: Stainless-steel rivets or self-tapping screws.
4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Metal Labels for Equipment:

1. Material and Thickness: Non-corroding metal, 20 gauge minimum thickness, and having predrilled or stamped holes for attachment hardware.

C. Plastic Labels for Equipment and Warning:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Equipment Label Color: Black letters on white background.
3. Warning Label Color: White letters on red background.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Warning Label Content: Include caution and warning information, plus emergency notification instructions.

E. Equipment Label Content: Include equipment's Drawing designation or unique equipment number.

F. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing plan numbers where equipment is indicated, plus the Specification Section number and title where equipment is specified. Equipment schedule shall be provided to the Controls Contractor and included in operation and maintenance data.

2.13 ROOF CURBS

- A. Description: Galvanized-steel sheet; with mitered and welded corners; and 1-1/2-inch wood nailer. Size as required to fit roof opening and equipment base.
 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 2. Height: Minimum 12 inches above the finished top of the roof, unless otherwise indicated. For fresh air/intake hoods, minimum height shall be 20 inches above the finished top of the roof.
 3. Insulation: 1-1/2-inch-thick, rigid fiberglass, adhered to inside walls.
 4. Coordination: The Mechanical Contractor shall furnish and install the roof curbs and coordinate with the insulation thickness on roofs where the insulation is above the roof deck and provide pressure treated wood blocking to bring the curb above the insulation

and membrane. In lieu of wood blocking, a full height prefabricated curb with a raised cant is acceptable if the height of the raised cant is the same height of the insulation thickness and the minimum height above the top of the finished roof is maintained.

2.14 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.15 THERMOSTATS

- A. Solid-State Thermostat:
 - 1. Type: Wall-mounting, programmable, microprocessor-based unit.
 - 2. Heat/Cool Switching: Automatic.
 - 3. Exposed set point.
 - 4. Exposed indication.
 - 5. Deg F indication.
 - 6. Battery backup protection against power failure for program settings.
 - 7. Programmability: Seven-day with minimum of four temperature presets per day.
- B. Single-Stage, Heating-Only Thermostat:
 - 1. Heat-Off switch.
 - 2. Fan on-Auto switch.
 - 3. Exposed set point.
 - 4. Exposed indication.
 - 5. Deg F indication.

2.16 FIRE-BARRIER PENETRATIONS

- A. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with Approved firestop materials. See Section 230500 for further details.
 - 1. Each Penetration shall be sealed by a Certified Installer, or this Contractor is to hire a Certified Installer to perform fire sealing.
 - 2. Each Penetration is to include a legible, permanent label that has the following information:
 - a. UL listing
 - b. Product used
 - c. Name of installer
 - d. Name of Contracting Company

- e. Date the seal was installed

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. All valves shall be installed in accessible locations. If any valve is found to be installed in a location deemed inappropriate by the Owner and/or Engineer, the contractor shall relocate the valve at no additional cost to the owner.
- B. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- C. Install valves in horizontal piping with stem at or above center of pipe in position to allow full stem movement.
- D. Install chainwheels on operators for butterfly, gate, and globe valves 4" and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- E. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.
- F. Install natural gas regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, or butterfly valves.
 - 2. Throttling Service: Ball or butterfly valves.
 - 3. Pump-Discharge Check Valves:
 - a. 2" and Smaller: Bronze swing check valves with bronze disc.
 - b. 2-1/2" and Larger: Iron silent check valves with rubber seats.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing and Steel Piping, 2" and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing and Steel Piping, 2-1/2" and Larger: Flanged ends.
- D. In general, ball valves are preferred over butterfly, gate, and globe valves on piping 2" and smaller. Butterfly are preferred on piping larger than 2".

3.3 PIPE HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Arrange for grouping of parallel runs of horizontal piping, and support together on trapeze pipe hangers.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses

from movement will not be transmitted to connected equipment.

- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- I. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. 4" and smaller: 12 inches long and 0.06 inch thick.
 - b. 5" and larger: 18 inches long and 0.06 inch thick.
 - 5. Pipes 8" and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- J. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- K. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- L. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- M. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- N. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- O. Use thermal-hanger shield inserts for insulated piping and tubing.
- P. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 °F piping installations.
- Q. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20 or 25): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod.
- R. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- S. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
- T. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

3.4 DUCT HANGER AND SUPPORT INSTALLATION

- A. Hanger Spacing: Maximum of 10 feet apart:
1. Rectangular Duct: Pair of straps or rods.
 2. Round Duct, up to 36" diameter: Single rod.
 3. Round Duct, greater than 36" diameter: Double rods or straps.
- B. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 1 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

3.7 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in below grade exterior concrete walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.8 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.9 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run.

3.10 FIRE-BARRIER PENETRATION PROTECTION

- A. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- B. Install Fire Stop Systems per the manufacturers guidelines.

3.11 VALVE SCHEDULE

- A. Gas Valves:
 - 1. Ball Valves.

3.12 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Galvanized-steel wall pipes.
 - b. PVC-pipes.
 - 2. Exterior Concrete Walls below Grade, Concrete Slabs-on-Grade:
 - a. Galvanized-steel wall sleeves with sleeve-seal system.
 - b. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3.13 ESCUTCHEON AND FLOOR PLATE INSTALLATION

- A. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors of finished areas.
- B. Install escutcheons for piping penetrations of walls within concealed cabinet spaces.
- C. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- D. Replace broken and damaged escutcheons using new materials.

3.14 THERMOSTAT SCHEDULE

- A. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.
- B. Install thermostats at mounting height of 48 inches above floor to center of device.
 - 1. Line voltage thermostats installed by Electrical Contractor.
 - 2. Mount on interior walls wherever possible. Provide insulation backing when mounting on exterior walls.
- C. Solid-State Thermostat:
 - 1. Offices
- D. Two-Stage, Heating Only Thermostat:
 - 1. Shop

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Common motor requirements for HVAC equipment.
 - a. General requirements for motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Single-phase motors.
 - 3. Three-phase motors.
 - 4. Electrically commuted motors.
 - 5. VFDs.
 - 6. Shaft grounding rings.

1.2 VFD QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.3 SUBMITTALS

- A. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.

1.4 WARRANTY

- A. Motor performance shall be warranted against material and workmanship defects by manufacturer's warranty and service policy for the period of at least 18 months from the day of shipment from the factory or the manufacturer's warehouse.
 - 1. Premium efficiency motors shall be warranted for 36 months.
 - 2. Severe duty motors (as applicable) shall be warranted for 60 months.
- B. VFDs: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Motor Characteristics:
 - 1. Duty: Continuous duty at ambient temperature of 105 °F and at altitude of 3500 feet above sea level.
 - 2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with

indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.2 SINGLE PHASE MOTORS

- A. Description: Single phase motor, T-Frame, 1.25 service factor, minimum class B insulation for 105°F ambient.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. General Electric.
 - 3. Marathon.
 - 4. Century.
- C. Motors 1/20 HP and Smaller: Shaded-pole type.
- D. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- E. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- F. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- G. Minimum Efficiency: 75 percent.
- H. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.3 THREE-PHASE MOTORS

- A. Description: NEMA MG-1, T-frame, Design B, induction-type motor, minimum class F insulation for 105°F ambient.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. General Electric.
 - 3. Marathon.
 - 4. WEG.
 - 5. TECO.
 - 6. NIDEC.
- C. Materials:
 - 1. Windings: Copper.
 - 2. Frame: Steel or cast iron.

3. Rotor: Random-wound, squirrel cage.
 4. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading, L-10 life of 200,000 hours.
- D. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
- E. Service Factor:
1. 1 HP and Smaller: 1.25
 2. Above 1 HP: 1.15
- F. Full-load Electrical Efficiency: Based on motor size as indicated below, and shall comply with ASHRAE 90.1-2013, whichever is greater:
1. 1 HP and Smaller: 81.5%
 2. Above 1 HP to 5 HP: 86.5%
 3. Above 5 HP: 91%
- G. Multispeed Motors: Variable torque.
1. For motors with 2:1 speed ratio, consequent pole, single winding.
 2. For motors with other than 2:1 speed ratio, separate winding for each speed.

2.4 THREE-PHASE MOTORS USED WITH VFD

- A. Description: Additional requirements for three-phase motors used with variable frequency controllers (VFD).
- B. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- C. Motors Used with Variable Frequency Controllers:
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

2.5 SHAFT GROUNDING RINGS

- A. Description: Conductive microfiber shaft grounding ring.
1. Meet NEMA MG-1 requirements.
 2. Factory installed whenever possible.
- B. Basis of Design: AEGIS, model SGR.
- C. Type: Minimum of two rows of circumferential fibers on solid ring or split ring.
- D. Application Note: Provide on motors greater than 1 HP.
1. Motors less than 100 HP: Mount ring on either the drive end or non-drive end.
 2. Motors 100 HP and above: Two shaft grounding rings, mounted on the drive end and the non-drive end.

2.6 ELECTRONICALLY COMMUTATED MOTORS

- A. Description: Brushless DC motor with built in speed and torque controls.
- B. Rotor: Permanent magnet.
- C. Circuitry: Programmable, manage commutation of stator to be always synchronous with rotor.
- D. Multispeed Motors: Minimum turndown of 80%.
- E. Efficiency: Minimum of 65%.
- F. Bearings: Permanently lubricated, heavy duty ball bearings.
- G. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.7 VARIABLE FREQUENCY DRIVES

- A. Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter).
 - 1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. ABB Automation Company.
 - 2. Cerus Industrial.
 - 3. Danfoss Inc.; Danfoss Drives Div.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 5. General Electric Company.
 - 6. Rockwell Automation, Inc.; Allen-Bradley Brand.
 - 7. Square D; a brand of Schneider Electric.
 - 8. Toshiba International Corporation.
- C. VFD General Requirements: Comply with NEMA ICS 7, NEMA ICS 61800-2.
 - 1. Integral Disconnect: Disconnect shall remove all power from unit.
- D. Application: Variable torque.
- E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: Plus 10% and minus 15% of VFD input voltage range rating; +/- 5% of VFD frequency rating.
 - 2. Output Rating: 3-phase; 10 to 120 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
 - 3. Environmental Operating Conditions: 32°F to 104°F, 0 to 3,300 feet above sea level, less than 95% (non-condensing).
 - 4. Minimum Efficiency: 96% at 60 Hz, full load.
 - 5. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8

- times the base load current for three seconds.
- 6. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
- 7. Speed Regulation: Plus or minus 5%.
- 8. Output Carrier Frequency: Selectable; 0.5 to 8 kHz.
- G. Inverter Logic: Microprocessor based, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 40:1 speed range.
- I. Internal Adjustability Capabilities:
 - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
 - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 - 3. Acceleration and Deceleration: 0.1 to 900 seconds.
 - 4. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
 - 1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 - 3. Under- and overvoltage trips.
 - 4. Inverter overcurrent trips.
 - 5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 - 6. Critical frequency rejection, with three selectable, adjustable deadbands.
 - 7. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - 8. Loss-of-phase protection.
 - 9. Reverse-phase protection.
 - 10. Short-circuit protection.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Input Line Reactance: Provide a minimum of 5% impedance on the input to the drive. If the standard drive design does not meet the specification of 5%, additional inductors shall be provided to bring the drive up to the specified level.
 - 1. Line reactors: Furnished and installed by the drive manufacturer in the VFD enclosure

from the factory. Field installed line reactors shall not be allowed.

P. Harmonic Mitigation:

1. DC bus reactors or Input AC line reactors.
2. Total Harmonic Distortion: Not exceed 10%.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors and accessories according to manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

3.2 SHAFT GROUNDING RINGS

- A. Shaft grounding rings (SGR) shall be factory installed inside the motors by the manufacturer wherever possible. SGR's may be field installed by installing contractor subject to Engineer's approval. Provide AEGIS SGR Colloidal Silver Shaft Coating, or approved equal, on shafts prior to rings installation, per SGR manufacturer's recommendations, after first cleaning shafts.
- B. Install and test SGR's in accordance with manufacturer's recommendations. Install the SGR so that the aluminum frame maintains an even clearance around the shaft. Conductive microfibers shall be in full circumferential contact with conductive metal surface of the shaft. Do not use thread lock to secure the mounting screws as it may compromise the conductive path to ground. If thread lock is required, use a small amount of EP2400 AEGIS Conductive Epoxy, or approved equal, to secure the screws in place.
- C. Shafts shall be clean and free of any coatings, paint, or other nonconductive material (clean to bare metal). Depending upon the condition of the shaft, it may require using emery cloth or Scotch-Brite. If the shaft is visibly clean, a non-petroleum based solvent may be used to remove any residue. Check the conductivity of the shaft using an ohm meter. Ohms test: Place the positive and negative meter leads on the shaft at a place where the microfibers will contact the shaft. Each motor will have a different reading but in general one should have a maximum reading of less than 2 ohms. If the reading is higher, clean the shaft again and retest.
- D. After motors with SGR are fully installed in the field (in equipment, assemblies, or individually), for both factory-installed-SGR and field-installed-SGR cases, test for a conductive path to ground using an Ohm meter. Place one probe on metal frame of SGR and one probe on motor frame. Motor must be grounded to common earth ground with variable frequency drive according to applicable standards. Verify that SGR installations and test readings comply with SGR manufacturer's requirements.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. The Contractor shall do all excavating and trench work necessary for the complete installation, as shown on the Drawings, for piping underground or under the floors.

1.2 QUALITY ASSURANCE

- A. Backfill under any Federal, State or Local Municipality highway or street shall be backfilled in compliance with all Federal, State and Local Municipalities Codes and Regulations. All material used for backfill under such highways and streets shall be inspected and approved by the governing Authority. Before any bituminous or concrete is placed over such fills, they shall be inspected and approved by the governing Authority.
- B. This Contractor shall repair, to the original condition, all sidewalks, curb, gutter, fence, streets or highways damaged or taken up to install outside services.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIALS

- A. Backfill in trenches inside and under building shall be sand or gravel materials approved by the Architect/Engineer.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILLING

- A. Bell holes shall be excavated to insure sewer pipe resting for its entire length upon the bottom of the trench. Banks of trenches shall be kept as nearly vertical as possible and, if required, shall be properly sheeted and braced. The pipe trenches outside the building, after the piping has been tested and approved, shall be backfilled with excavated materials free from large clods or stones, carefully deposited in layers of 6"-8" in thickness on both sides of the pipe and thoroughly and carefully rammed until enough fill has been placed to provide a cover of not less than one foot above the pipe. The balance of the fill shall be deposited in layers not to exceed 9" in thickness and compacted to the density Specified under Compaction.
- B. All materials excavated shall be deposited on the side of the trenches beyond reach of slides. Excavated material shall not be piled where it will interfere with traffic or other trade's work. All earth taken from trenches shall be deposited as directed or removed from site, as directed by the Architect/Engineer.
- C. No pipes or PVC conduit shall be bedded directly on rock, but shall be cushioned by a 6" layer of sand or as approved by the Architect/ Engineer.
- D. Maintain excavation in good order and provide bracing where necessary to prevent caving, settlement, or damage. Provide necessary pumps, power, suction and discharge lines to keep all excavation free from standing water.
- E. All excavations are to be completed in a workmanlike manner, level and smooth.
- F. Backfill under concrete or bituminous slabs, curbs, streets, parking lots, driveways, sidewalks or any other concrete items shall be of coarse gravel or material approved by the

Architect/Engineer. Water shall be used as necessary to insure proper compaction of fill.

3.2 CLEANING

- A. All areas to be backfilled shall be thoroughly cleaned of all construction and other debris.

3.3 COMPACTION

- A. Compaction shall be done in lifts as the backfill is deposited in layers as specified above.
- B. Compaction shall be to % of Standard Proctor density as listed below:
 - 1. Grassed areas: 85% of Standard Proctor.
 - 2. Under pavements and walks: 90% of Standard Proctor.
 - 3. Under building floor slabs: 95% of Standard Proctor.
- C. Moisture content shall be within 2% to 3% optimum moisture as determined by ASTM D-698. Compaction density shall be as determined by ASTM D-698.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Duct Insulation.
 - 2. Fire-rated Insulation Systems.
- B. The work covered by this Specification consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of all insulation for the HVAC systems, in strict accordance with Section 230700 of this Specification and applicable Drawings and subject to the terms and conditions of the Contract.

1.2 REFERENCE

- A. Related work in Section 220700 "Plumbing Insulation."

1.3 SUBMITTALS

- A. Shop Drawings: For materials covered under this section as per Section 230500.
 - 1. Product Data: Each type of insulation.
- B. Operation and Maintenance Data: Per section 230500.
 - 1. Product Data: Each type of thermal and fire-rated insulation systems.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. All insulation shall be installed in a workmanlike manner by skilled workmen regularly engaged in this type of work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
 - 1. Owens-Corning Fiberglass.
 - 2. Johns Manville.
 - 3. Knauf Insulation.
- B. All manufacturers are subject to compliance with requirements.
- C. Provide products by one of the manufacturers specified or by prior approval.

2.2 COMMON INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

2.3 INSULATION

- A. Fiberglass Wrap: Glass fibers bonded with a thermosetting resin; FSK or ASJ Max jacket. Comply with ASTM C 553, Type II and ASTM C 1290, Type I and Type III.
- B. Fiberglass Board: Glass fibers bonded with a thermosetting resin, semi-rigid; FSK or ASJ Max jacket. Comply with ASTM C 612, Type IA or Type IB.
- C. Fiberglass, Preformed Pipe Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ.

2.4 INSULATION JACKETS

- A. ASJ Max Jacket: Poly-encapsulated paper jacket; Factory applied shall comply with ASTM C1136, Type I, II, III, IV.
- B. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; Factory applied shall comply with ASTM C1136, Type II.
- C. Self-Adhesive Outdoor Jacket: 5-ply high strength composite, self-adhesive, 7-mil-thick, laminated vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white or stucco-embossed aluminum-foil facing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Polyguard Products; Alumaguard series.
 - b. Venture Tape; VentureClad series.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14; stucco embossed, 0.016" thick.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Childers Brand, Specialty Construction Brands, Inc.
 - b. Metal Jacketing Systems.
- E. PVC Jacket: Comply with ASTM D1784, Class 16354-C. High impact resistant, UV resistant, minimum 0.030" thick.

2.5 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.6 SEALANTS

- A. Joint Sealants: Permanently flexible, elastomeric sealant, compatible with insulation

materials, jackets, and substrates.

2.7 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

2.8 TAPES

- A. Tapes: Match jacket with compatible adhesive as recommended by jacket manufacturer.
- B. ASJ Max Tape: Foil-face, vapor-retarder tape; complying with ASTM C 1136, 3 inches wide.
- C. FSK Tape: Foil-face, vapor-retarder tape; complying with ASTM C 1136, 3 inches wide.
- D. Aluminum-Foil Tape: Vapor-retarder tape, 2 inches wide.
- E. PVC Tape: White vapor-retarder PVC tape, 2 inches wide.

2.9 SECUREMENTS

- A. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - 1. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - 2. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - 3. Adhesive-backed base with a peel-off protective cover.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 12 gauge nickel-copper alloy or 14 gauge soft-annealed, stainless steel or 14 gauge soft-annealed, galvanized steel.

2.10 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. CertainTeed Corp.; FlameChek.
 - 2. Johns Manville; Firetemp Wrap.
 - 3. 3M; Fire Barrier Wrap Products.
 - 4. Unifrax Corporation; FyreWrap.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install multiple layers of insulation with longitudinal and end seams staggered.
- C. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- D. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic. Install insulation continuously through hangers and around anchor attachments.
- E. Install insulation with jackets as follows:
 - 1. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip.
 - 2. Overlap jacket longitudinal seams at least 1-1/2 inches. Staple laps with outward clinching staples along edge.
 - 3. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 4. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- F. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

- A. Roof/Wall Penetrations: Install insulation continuously through roof/wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof/wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside flashing at least 2 inches.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Fire-Rated Wall and Partition Penetrations:
 - 1. Duct: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 2. Pipe: Terminate insulation at fire-rated wall and partition penetrations.
 - 3. See Specification Section 230510 for further Fire-Barrier Penetration requirements.
- D. Floor Penetrations:
 - 1. Duct: For penetrations through fire-rated assemblies, insulate with same procedure as with Fire-Rated Walls.

2. Pipe: Install insulation continuously through floor penetrations. Seal penetrations through fire-rated assemblies. Install insulation per UL Fire Stop System guidelines for pipe material and size.
3. See Specification Section 230510 for further Fire-Barrier Penetration requirements.

3.4 FIBERGLASS INSTALLATION

- A. General Procedures:
 1. Apply adhesives according to manufacturer's recommended coverage rates of duct and plenum surfaces.
- B. Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 1. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 2. Install pins on sides and bottom of horizontal ducts and sides of vertical ducts wider than 12 inches. Cover exposed pins and washers with tape matching insulation facing.
 3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier.
- C. Insulation Installation for Tanks and Vessels: Secure with adhesive and anchor pins.
 1. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 2. Do not weld anchor pins to ASME-labeled pressure vessels.
 3. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. Secure each layer of insulation with stainless-steel or aluminum bands.
 5. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 6. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 7. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.5 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07.

3.6 INDOOR DUCT AND PLENUM SCHEDULE

- A. Fiberglass wrap, with FSK jacket:
 1. Supply-Air Ducts and Plenums in attics, concealed spaces and unconditioned spaces.
 2. Tempered-Fresh-Air Ducts in attic spaces.
 3. Exhaust-Air Ducts and Plenums between isolation damper and penetration of building

- exterior.
 - a. Exception: Lined Exhaust-Air Duct from power roof ventilators.
- 4. Mixed-Air Ducts and Plenums.
- 5. Dishwasher Exhaust-Air Duct back 10' from roof exhaust fan.
- 6. Return-Air Duct and Plenums in attic spaces.
- 7. Tempered-Fresh-Air Duct and Plenums in spaces other than attic.
- 8. Un-tempered Fresh-Air Duct from air-to-air heat exchangers.
- B. Fiberglass board, welded board pins, with FSK facing and matching label-less FSK tape:
 - 1. Outdoor-Air Duct and Plenums.
 - 2. Ducts and Plenums in Mechanical Rooms.
 - a. Provide one of the following additional means of sealing and cladding:
 - i. Mastic-canvas-mastic.
 - ii. Mastic-fiberglass scrim cloth-mastic.
 - iii. Self-adhering, peel and stick, rubberized bitumen jacket.
- C. Insulation not required:
 - 1. Exhaust-Air Duct except as otherwise
 - 2. Return-Air Duct and Plenums in indirectly conditioned spaces.
 - 3. Supply-Air Ducts and Plenums in exposed, conditioned spaces.
 - 4. Tempered-Fresh-Air Ducts.
 - 5. Fibrous-glass ducts.
 - 6. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 7. Factory-insulated flexible ducts.
 - 8. Factory-insulated plenums and casings.
 - 9. Flexible connectors.
 - 10. Vibration-control devices.
 - 11. Factory-insulated access panels and doors.
 - 12. Listed grease ducts.
- D. Minimum Duct Insulation R-Values
 - 1. Supply ducts, installed in unheated attics and exterior: R-12.
 - 2. Supply ducts, installed in unconditioned spaces, ceiling plenums, and crawl spaces: R-6.
 - a. Exception: Cooling only supply ducts: R-2.
 - 3. Supply ducts, installed in attic with roof insulation: R-2.
 - 4. Return ducts, installed in unheated attics: R-4.
 - 5. Outside air ducts: R-12.
 - 6. Un-tempered Fresh-Air Ducts: R-4.

3.7 EXTERIOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Fiberglass board, with self-adhesive outdoor jacket or aluminum jacket.
 - 1. Supply, Return Ducts and Plenums: 2" thick and 3-lb/cu. ft. nominal density, R-8 minimum.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Pipe and fitting materials, and joining methods for the following:
 - a. Condensate-drain piping.
 - b. Natural gas piping.

1.2 REFERENCE

- A. Refer to Section 230510 "Common Work Results For HVAC" for requirements of hangers, sleeves, sleeve seals, and escutcheons.

1.3 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Product Data: Provide a separate shop drawing for each of the following piping systems showing the material and fastening method chosen by the contractor:
 - a. Condensate drainage.
 - b. Aboveground natural gas.
 - c. Underground natural gas.

1.4 QUALITY ASSURANCE

- A. All piping shall be installed in a workmanlike manner by skilled workmen regularly engaged in this type of work.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K, annealed temper.
- C. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- D. Grooved-End Copper Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze

- casting.
- 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 °F for use with housing, and steel bolts and nuts.
- E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- F. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- G. Copper Pressure-Seal Fittings: ASME B16.51, press-connect pressure fittings.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Apollo.
 - b. Mueller Streamline Co.
 - c. NIBCO, Inc.
 - d. Viega, LLC.
 - 2. Fittings for 2" and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end with leakage path feature to provide identification of un-pressed connections.
 - 3. Fittings for 2-1/2" to 4": Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal and stainless-steel grip in each end.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes as indicated in Part 3 "Piping Applications" Article.
- C. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- G. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 - 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to

accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

H. Cold Press Mechanical-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - a. Viega, LLC.
2. Fittings: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria of ANSI/CSA LC4. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.
 - a. Gas Fittings: Conform to material requirements of ASME B31.9 and performance criteria of ANSI/CSA LC4a/CSA 6.32a.

2.3 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
 1. Flame Spread: Less than 25 per ASTM E84/UL723.
 2. Smoke Developed Index: Less than 50 per ASTM E84/UL723.
- B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
 1. Flame Spread: Less than 25 per ASTM E84/UL723.
 2. Smoke Developed Index: Less than 50 per ASTM E84/UL723.
- C. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- D. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.4 HIGH DENSITY POLYETHYLENE (HDPE) PIPING

- A. All pipe and heat-fused materials shall be manufactured from a virgin polyethylene extrusion compound material in accordance with ASTM-D2513, sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness, and respective tolerances as specified in ASTM D-3035 or D-2447.
- B. The material shall have a Hydrostatic Design Basis of 1600 psi at 73°F per ASTM D-2837. The material shall be a high-density polyethylene compound having a minimum cell classification of PE345464C per ASTM D-3350.
- C. Dimensions
 1. 1-1/4" and less shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 11.
 2. 1-1/2" to 2-1/2" shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 15.5

3. 3" and larger shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 17.
- D. Heat fused fittings in accordance with pipe manufacturer's procedures.
- E. Fusion transition fittings with reinforced threads shall be used to adapt to metal or reinforced hose connection fittings. Barbed fittings are not an acceptable transition to polyethylene pipe.

2.5 CORRUGATED, STAINLESS-STEEL TUBING

- A. Comply with ANSI/IAS LC 1.
- B. Manufacturers: Subject to compliance with requirements, provide piping by one of the following or other prior approved:
 1. OmegaFlex, Inc.
 2. Parker Hannifin Corporation; Parflex Division.
 3. Titeflex.
 4. Tru-Flex Metal Hose Corp.
- C. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
- D. Coating: PE with flame retardant.
 1. Surface-Burning Characteristics: As determined by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 50 or less.
- E. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends.
- F. Striker Plates: Steel, designed to protect tubing from penetrations.
- G. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections for pipe inlet and corrugated tubing outlets.
- H. Operating-Pressure Rating: 5 psig.

2.6 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings shall be CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions, and one end with threaded brass or stainless steel insert and one solvent-cement-socket end.
- B. Plastic-to-Metal Transition Unions shall be CPVC four-part union with brass threaded end, solvent-cement-joint plastic end, rubber O-ring gasket, and union nut.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Nipple:
 1. Comply with ASTM F1545.
 2. Pressure Rating: 425 psi at 225°F.

3. Materials: Carbon steel body with crosslinked polyethylene (PEX) plastic insert.
- C. Dielectric Unions:
1. Standard: ASSE 1079.
 2. Pressure Rating: 125 psig minimum at 180 °F.
 3. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 GAS PIPING SPECIALTIES

- A. Line Pressure Regulators: Soft valve seat to permit bubble tight lock up under no-flow conditions.
1. Comply with ANSI Z21.18.
 2. Body and Diaphragm Case: Die-cast aluminum or cast iron.
 3. Springs: Zinc-plated steel; interchangeable.
 4. Diaphragm Plate: Zinc-plated steel.
 5. Seat Disc: Nitrile rubber.
 6. Orifice: Aluminum; interchangeable.
 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150% of design discharge pressure at shutoff.
 9. Overpressure Protection Device: Factory mounted on pressure regulator.
- B. Appliance Flexible Connectors:
1. Indoor, Appliance Flexible Connectors: Comply with ANSI Z21.24 (fixed appliance) or with ANSI Z21.69 (moveable appliance).
 2. Corrugated stainless-steel tubing with polymer coating.
 3. Operating-Pressure Rating: 0.5 psig.
 4. End Fittings: Zinc-coated steel, threaded ends.
 5. Maximum Length: 72 inches.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
- B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- C. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Exposed piping shall be run as high as possible except where noted otherwise.
- E. Install piping to permit valve servicing and free of sags and bends.
- F. Install press fittings with a minimum spacing of 1" between fittings.
- G. Select system components with pressure rating equal to or greater than system operating pressure.

- H. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- I. Install drains, consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- J. Install unions or flanges in piping, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- K. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- L. Install 3/4" nipple and ball valve in blowdown connection of strainers 2" and larger. Match size of strainer blowoff connection for strainers smaller than 2".
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.
- N. Install sleeve seals for piping penetrations of below grade concrete walls and slabs.
- O. Install escutcheons (chrome plates) for exposed piping penetrations of finished walls, ceilings, and floors.

3.2 GENERAL GAS PIPING INSTALLATION

- A. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.
 - 1. Construct sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 6 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- B. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- C. Connect branch piping from top or side of horizontal piping.
- D. Install unions in pipes 2" and smaller, adjacent to each valve, at final connection to each piece of equipment.
- E. Do not use natural-gas piping as grounding electrode.
- F. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping adjacent to appliances to allow service and maintenance of appliances.
- I. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment. Provide restraining cable from moveable appliances to wall.

3.3 NATURAL GAS PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Connect to regulator at gas meter. Prime and paint all exterior metal piping to protect from corrosion.
 - 1. Clean piping to remove loose dirt and debris prior to applying primer. Sand any rust

- spots with 220-grit sandpaper; rinse pipe with water and allow to dry.
 2. Apply metal primer paint to clean exterior piping.
 3. Apply two coats of enamel-based metal topcoat paint. Allow the first coat to thoroughly dry before applying second coat.
- C. Provide sign indicating emergency generator support mounted on wall next to valve on pipe to generator. Sign shall read as follows:
1. This gas valve supplies fuel for emergency stand-by generator. When this valve is shut off, emergency power is not available.
- D. All underground service piping to building and all meters and exterior regulators will be furnished and installed by the Utility Company and costs related to this service and meter installation are to be billed directly to the Owner by the Utility Company. It is the Division 23 Contractor's responsibility to coordinate with utility, so the underground gas line is installed at the appropriate time during construction.
- E. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
1. Corrugated stainless steel tubing (CSST) shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream CSST fitting. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent.

3.4 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 50 feet long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 50 feet or longer.
 3. Install trapeze hanger for multiple parallel piping 50 feet or longer.
 4. Spring hangers to support vertical runs.
 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
 7. Install hanger 12" from elbow joint.
- B. Install hangers for steel piping as follows:
1. 1" and smaller: 8 feet with 3/8-inch rod.
 2. 1-1/4" to 3": 10 feet with 3/8-inch rod.
 3. 4" to 6": 12 feet with 1/2-inch rod.
 4. 8" and larger: 12 feet with 5/8-inch rod.
- C. Install hangers for drawn-temper copper piping as follows:
1. 1-1/2" and smaller: 6 feet with 3/8-inch rod.
 2. 2" to 4": 10 feet with 3/8-inch rod.
 3. 6" and larger: 10 feet with 1/2-inch rod.
- D. Install hangers for CPVC and PVC as follows:
1. 1" and smaller: 3 feet with 3/8-inch rod; 8 feet with pipe support channel and 3/8" rod.

2. 1-1/4" to 3": 4 feet with 3/8-inch rod; 8 feet with pipe support channel and 3/8" rod.
 3. 4" to 6": 4 feet with 1/2-inch rod; 10 feet with pipe support channel and 1/2" rod.
 4. 8" and larger: 4 feet with 5/8-inch rod; 10 feet with pipe support channel and 5/8" rod.
- E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- F. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

3.5 PIPING APPLICATIONS

- A. Piping materials are identified below. If more than one material is listed for an application, selection from materials listed is Contractor's option.
- B. Condensate-Drain Piping:
1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
 3. For all reverse osmosis condensate piping, use humidifier manufacturer approved stainless steel tubing with welded joints and fittings.
- C. Natural Gas Piping:
1. Aboveground: Black steel, Schedule 40, Type E or S, Grade B.
 - a. Paint all exterior piping to prevent corrosion.
 - b. Malleable-iron threaded fittings or wrought-steel welding fittings: 2" or smaller.
 - c. Cold Press Mechanical-Joint Fittings:
 - i. 2" or smaller.
 - ii. Systems with gas pressure 5 psi and lower.
 - d. Welded Fittings:
 - i. Systems with gas pressure 2 psi and higher.
 - ii. Piping larger than 2".
 - iii. Piping in inaccessible areas.
 - e. Unions: Malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - f. Corrugated stainless-steel tubing may be used at following locations:
 - i. From drip leg tee to equipment, 1" or smaller.
 - ii. Inaccessible locations, 1-1/2" or smaller, 75' maximum length.
 - iii. Where noted on drawings.
 2. Underground:
 - a. Copper, Type ACR L, with factory-applied PE protective coating.
 - b. HDPE piping, approved fittings.
 - c. Stainless steel tubing, ASTM A268 or A269.
 - i. Corrugated stainless steel tubing shall not be used underground.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ducts and fittings.
 - 2. Sheet metal materials.
 - 3. Sealants and gaskets.
 - 4. Hangers and supports.
 - 5. Dampers.
 - 6. Access doors.
 - 7. Turning vanes.
 - 8. Duct-mounted access doors.
 - 9. Flexible connectors.
 - 10. Flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

1.3 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Round ducts and fittings: Materials, drawings of fittings with method of assembly.
 - 2. Dampers: Make and model, components, materials, drawings with dimensions and field connections.
- B. Operation and Maintenance Manuals: For equipment where shop drawings were submitted this section as per Section 230500.

1.4 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified period.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on 2" static-pressure class unless otherwise indicated.
- B. Ductwork shall be fabricated in accordance with the following schedule:
 - 1. Up to 12" Width: 26 Gauge
 - 2. Up to 30" Width: 24 Gauge
 - 3. Up to 60" Width: 22 Gauge
 - 4. Up to 90" Width: 20 Gauge
 - 5. 90" Width and Up: 18 Gauge

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Fabricated Duct Systems
 - 2. Norlock Metal Products, Inc.
 - 3. SEMCO Incorporated.
 - 4. Spiral Manufacturing Co., Inc.
 - 5. Tangent Air, Inc.
 - 6. United Sheet Metal
- C. Ductwork shall be fabricated in accordance with the following schedule:
 - 1. 3"-14" Diameter: 26 Gauge
 - 2. 15"-26" Diameter: 24 Gauge
 - 3. 28"-36" Diameter: 22 Gauge
 - 4. 38"-50" Diameter: 20 Gauge
 - 5. 52"-60" Diameter: 18 Gauge
 - 6. 61" and Above: 16 Gauge
- D. Transverse Joints in Ducts Larger Than 60 inches in Diameter: Flanged.
- E. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized, or primed with DTM (Direct to Metal) paint equivalent to Sherwin Williams B42W series.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 4.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-

inch minimum diameter for lengths longer than 36 inches.

2.4 RECTANGULAR DUCT CONNECTION SYSTEM

- A. Description: Roll-formed flanges, corner pieces, gasket and metal cleat.
1. Sealer: Integral mastic meeting NFPA 90A and 90B Class I requirements.
 2. Gasket: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
 3. Schedule: Rectangular ductwork with perimeter greater than 120".

2.5 METAL DUCT SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Water resistant, mold and mildew resistant.
 4. Maximum Static-Pressure Class: 6-inch wg, positive and negative.
 5. Service: Indoor and outdoor.
 6. Service Temperature: Minus 20 to plus 200 °F.
 7. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. Water-Based Joint and Seam Sealant (Mastic):
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Water resistant, mold and mildew resistant.
 4. Maximum Static-Pressure Class: 6-inch wg, positive and negative.
 5. Service: Indoor or outdoor.
 6. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type S, grade NS, class 25, use O.
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

2.6 DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Cesco Products; a division of Mestek, Inc.

2. Greenheck Fan Corporation.
 3. NCA Manufacturing, Inc; Metal Industries, Inc.
 4. Nailor Industries Inc.
 5. Pottorff.
 6. Ruskin Company.
 7. Vent Products Company, Inc.
- B. Backdraft Dampers - Rectangular:
1. Description: Gravity balanced.
 2. Up to 2" wg. System Pressure:
 - a. Frame: 0.125"-thick extruded aluminum.
 - b. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050"-thick aluminum with sealed edges.
 3. Blade Action: Parallel.
 4. Blade Seals: Felt or Vinyl foam for silent operation.
 5. Blade Axles: Aluminum.
 6. Accessories: Adjustment device to permit setting for varying differential static pressure.
- C. Backdraft Dampers - Round:
1. Description: Spring operated. Suitable for vertical airflow, up or down; and horizontal airflow.
 2. Frame: 20 ga. galvanized steel.
 3. Blades: Multiple single-piece blades, galvanized steel.
 4. Blade Seals: Closed cell neoprene foam for silent operation.
 5. Blade Axles: Plated steel.
- D. Manual Volume Dampers:
1. Standard, Galvanized Steel, Manual Volume Dampers:
 - a. Suitable for horizontal or vertical applications.
 - b. Single blade, or multiple, opposed-blade design.
 2. Adjustable quadrants or regulators: Plainly marked to indicate position of damper, with locking nut.
- E. Control Dampers:
1. Furnished under Section 230900, installed by Division 23 except where otherwise noted.
 2. AMCA-rated; galvanized-steel or extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 16 ga. galvanized steel with maximum blade width of 6 inches and length of 48 inches.
 - a. Secure blades to zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - b. Operating Temperature Range: From -40°F to 200°F.
 - c. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

2.7 ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Cesco Products; a division of Mestek, Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. MIFAB.
 - 5. Nailor Industries Inc.
 - 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Door: Foam gasket, galvanized sheet metal with 1" insulation fill.
 - 1. Vision panel where noted in Access Door Installation article.
 - 2. Hinges and Latches: Piano hinge and cam latches.
 - 3. Size: 12"x12", unless otherwise noted.
- C. Frame: Galvanized sheet steel, with foam gaskets.

2.8 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 16 gauge carbon steel or 18 gauge stainless steel. Material shall match duct.
- D. Fasteners: Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 °F.

2.9 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Ductmate Industries, Inc.
 - 2. SEMCO Incorporated.
 - 3. Tuttle & Bailey.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

2.10 VOLUME EXTRACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:

1. Krueger.
 2. Nailor Industries.
 3. Tuttle & Bailey.
- B. Manufactured Volume Extractors: Gange operated, curved blades of galvanized sheet steel to extract air from main duct to stub duct.
1. Blad Spacing: 1”.
 2. Adjustment Type: Rod operator, external adjustment, with locking device.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Either of the following:
1. Factory fabricated with a fabric strip not less than 6” wide attached to two strips of metal compatible with connected ducts.
 2. Field fabricated with a fabric strip not less than 6” wide clamped to duct by 1”x1”x1/8” angles attached with 5/16 bolts or self-tapping screws, 6” on center.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
 2. Service Temperature: Minus 40 to plus 200 °F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd.
 2. Service Temperature: Minus 50 to plus 250 °F.

2.12 HIGH EFFICIENCY TAKEOFF

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other equivalent:
1. Ductmate Industries, Inc.
 2. Lukjan Metal Products.
 3. Sheet Metal Connectors, Inc.
- B. Manufactured to conform to SMACNA 2005 duct construction standards:
1. Material: Match duct material, minimum 24 gauge.
 2. Body: 45° slope, rectangular opening transition to round.
 3. Gasket: EPDM rubber
 4. Damper: Minimum 24 gauge, manual volume damper.

2.13 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Thermaflex.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Used for ventilation only systems.
- C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Insulation: Minimum R-3.5, except in attics: R-6.
- D. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.

PART 3 - EXECUTION

3.1 DUCTWORK INSTALLATION

- A. Ductwork shall be run as high as possible in all rooms to maintain proper headroom. Where two or more ducts cross each other, they must be arranged in such a manner as to maintain the greatest possible clearance underneath.
- B. Ductwork shall not cover any electrical outlets or junction boxes. Consult with other trades to avoid interference with piping runs, etc.
- C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- D. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- E. Ducts shall conform to dimensions on the Drawings unless location of structural members prohibit. Make minor changes in run of certain ducts without extra cost to the Owner if necessary to avoid unforeseen structural or other interferences.
- F. All ductwork, where internal insulation is to be applied, shall be increased in size so the net internal dimension is that indicated on the Drawings.
- G. In case of a change in dimension, cross-sectional areas shall be maintained. Changes in size throughout shall be of perfect rectangular cross sections with a slope of approximately 1 to 4. Abrupt changes or offsets will not be accepted.

- H. All ducts shall be straight and smooth on the inside with finished joints. No inside standing seams will be permitted in ductwork. No single thickness partitions shall be allowed between ducts. The Engineer reserves the right to order any open seams or joints made tight by caulking or taping. No open joints at corners or elsewhere will be allowed.
- I. Where space permits, elbows shall have a centerline radius equal to 1½ times their width. Shorter radius and square throat elbows shall be used where required to fit restricted areas only and where required by the duct connection details on the Drawings. All short radius and square throat elbows shall be provided with turning vanes.
- J. All vertical ducts or risers shall be self-supporting.
- K. Watertight drip pans shall be provided below all power vent, relief vent, gravity vent, fresh air and exhaust openings through roof, either built into the ductwork or, if no duct is installed, independently suspended below opening. All fresh air, exhaust air and relief air louver plenums shall have watertight seams on bottom portion of plenums. All fresh air ductwork and other ductwork, as noted on the Plans, shall be caulked watertight.

3.2 METAL DUCT SEALING

- A. Seal ducts for duct static-pressure, and seal levels specified in "Duct Schedule" Article.
- B. Leakage Class Definition: Leakage class of 6 means that 6 cfm of leakage per 100 sq ft of duct surface is the maximum allowable threshold if tested at 1 inch test pressure.
- C. Duct Seal Levels Definitions:
 - 1. Level A: All transverse joints, longitudinal seams, and duct wall penetrations. Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B and the tape is used in accordance with that certification.
 - 2. Level B: All transverse joints, and longitudinal seams. Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL-181A or UL-181B and the tape is used in accordance with that certification.
 - 3. Level C: Transverse joints only.

3.3 DUCT LINER INSTALLATION

- A. All ducts requiring insulation shall be lined by carefully adhering the liner in a continuous piece to clean, flat metal sheets with a quick tacking, fire-retardant adhesive.
- B. Coated side of duct liner shall face the air stream.
- C. All exposed edges shall be coated with adhesive.
- D. Ducts over 24" width or breadth shall have liner additionally secured with spot welded pins and washers, one pin and washer to each two square feet of duct liner.

3.4 CONNECTIONS

- A. Make connections to inlet and outlet of all fans and air handling units with flexible connectors.
 - 1. Exception: Fan housings that have the entire fan and motor assembly isolated for vibration.
- B. Connect supply flexible duct to main duct with high efficiency takeoff.
- C. Connect diffusers or light troffer boots to ducts with maximum 10-foot lengths of flexible

duct.

3.5 ACCESS DOOR INSTALLATION

- A. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Upstream of duct coils.
 - 2. Downstream from control dampers and backdraft dampers.
 - 3. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links.
 - 4. Downstream from humidifiers. Include vision panel.
 - 5. Elsewhere as indicated.
- B. Label access doors according to Section 230510, Article "Equipment and Warning Labels" to indicate the purpose of access door.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

3.7 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated:
- B. Supply Ducts:
 - 1. Pressure Class: Minimum of 0.25-inch wg. greater than scheduled static pressure of attached supply fan.
 - 2. Duct seal levels for pressure class up to 2-inch w.c.:
 - a. Outdoor: A
 - b. Unconditioned Spaces: B
 - c. Conditioned Spaces: C
 - 3. Duct seal levels for pressure class greater than 2-inch w.c.:
 - a. Outdoor: A
 - b. Unconditioned Spaces: A
 - c. Conditioned Spaces: B
- C. Return Ducts:
 - 1. Pressure Class: Minimum of 0.25-inch wg. greater than scheduled static pressure of attached supply fan.
 - 2. Duct seal levels for all pressure classes:
 - a. Outdoor: A
 - b. Unconditioned Spaces: B
 - c. Conditioned Spaces: C
- D. General Exhaust Ducts:

1. Pressure Class: Minimum of 0.25-inch wg. greater than scheduled static pressure of attached exhaust fan.
 2. Duct seal levels for all pressure classes:
 - a. Outdoor: C
 - b. Unconditioned Spaces: C
 - c. Conditioned Spaces: B
- E. Intermediate Reinforcement:
1. Reinforcement:
 - a. Angle type: 1-1/2" x 1-1/2" x 1/8" thick.
 - b. Zee type: 1" (h) x 3/4" (w) x 1/8" thick
 - c. Channel type: 1-1/8" (h) x 3" (w) x 1/8" thick
 2. Spacing: 5 feet
 - a. Up to 1" static: Ducts and plenums over 60".
 - b. Up to 3" static: Ducts and plenums over 48".
 - c. Over 3" static: Ducts and plenums over 36".
- F. Elbow Configuration:
1. Rectangular Duct, Elbow:
 - a. Supply: Mitered with vanes.
 - b. Return: Mitered with vanes where indicated.
 2. Rectangular Duct, Radius:
 - a. No Vanes: Minimum radius is equal to duct width.
 - b. With Vanes: Minimum radius is equal to 1/2 of duct width.
 3. Round Duct, Minimum Centerline Radius:
 - a. Up to 18" diameter duct: 1/2 duct diameter.
 - b. 19" diameter duct and larger: Same as duct diameter.
- G. Branch Configuration: high-efficiency take-off.
1. Saddle tap allowed on existing round duct.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Cabinet fans (ceiling).
 - 2. Inline fans – centrifugal.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Fan Product Data: Include certified performance curves and rated capacities, dampers, motor ratings, and accessories for each type of product indicated. Indicate fan's operating point on curves.
- B. Operation and Maintenance Manuals: For equipment covered under this section as per Section 230500.

1.3 QUALITY ASSURANCE

- A. Motors: Comply with requirements in Section 230520 "General Motor Requirements."

1.4 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified period.
 - 1. Fan Warranty Period: Not less than one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Except where otherwise noted, the following general requirements shall apply:
 - 1. Fans shall bear the AMCA Certified Ratings Seal for air performance.

2.2 FANS GENERAL REQUIREMENTS

- A. Factory-installed and -wired disconnect switch.
- B. Fan Wheel: Statically and dynamically balanced in accordance to AMCA Standard 204-05.
- C. Propeller Wheel:
 - 1. Securely attached to fan shaft, keyed.
- D. Centrifugal Backward-Inclined Wheels:
 - 1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
 - 2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
- E. Centrifugal Forward-Curved Wheels:

1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
 2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- F. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway; anti-corrosive coating.
- G. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Minimum L_{10} life in excess of 100,000 hours (equivalent to L_{50} average life of 500,000 hours), at maximum cataloged operating speed.
 3. Exception: Cabinet Fans (Ceiling).
- H. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 5. Belts: Oil resistant, nonsparking, and nonstatic.
 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 7. Motor Mount: Adjustable for belt tensioning.

2.3 MANUFACTURERS

- A. Except in other Part 2 articles where noted, the following manufacturers are acceptable:
1. Acme.
 2. Carnes.
 3. Captive-Aire.
 4. Cook.
 5. JencoFan.
 6. Greenheck.
 7. New York Blower.
 8. Peerless Blowers.
 9. PennBarry.
 10. S&P Ventilation Systems.
 11. Twin City Fan & Blower; Twin City Fan Companies, Ltd.
- B. All manufacturers are subject to compliance with requirements
- C. Provide products by one of the manufacturers specified or by prior approval.

2.4 CABINET FANS (CEILING)

- A. Description: Factory assembled with one or more centrifugal wheels, direct drive, enclosed in housing, with inlet grille and integral backdraft damper; AMCA rated.
- B. Housing: Steel, lined with acoustical insulation, outlet collar.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft with motor and fan mounted with resilient isolators. Fan shrouds, motor, and fan wheel shall be removable for service.
- D. Grille: Plastic, non-yellowing, louvered designer grille.
- E. Electrical Requirements: Junction box for electrical connection in housing and receptacle for motor plug-in.
- F. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
 - 6. Manufacturer's standard wall cap, and transition fittings.

2.5 INLINE FANS – CENTRIFUGAL

- A. General Description: Inline fan with square housing and backward-inclined or forward curved centrifugal fan wheels.
- B. Housing: Heavy gauge galvanized steel with square duct mounting collars.
 - 1. Housing and Bearing Supports: Heavy gauge bolted and welded steel.
 - 2. Service Access: Removable side panels.
 - 3. Name Plate: Permanently attached displaying model and serial number of unit.
- C. Fan Wheel: Aluminum, matching inlet venturi, non-overloading, backward inclined.
- D. Accessories:
 - 1. Bearing Lubrication: Extended lube lines with Zerk fittings.
 - 2. Belt Driven Units: Belt Guard.
 - 3. Vibration Isolators: Neoprene/Rubber mount.
 - 4. Insulated housing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions
- B. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Ensure roof openings are square, accurately aligned, and correctly located
- C. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM)

and contract drawings.

- D. For dryer booster fans, mount pressure switch in the exhaust duct behind the dryer in the dryer vent recessed box.

3.2 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction to ensure that, except for normal weathering, devices will be without damage or deterioration at time of substantial completion.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Grilles, Registers, and Diffusers.
 - 2. Roof hoods.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Louver Product Data: Show frame profiles and blade profiles, angles, and spacing. Include color selection chart.
- B. Operation and Maintenance Manuals: For equipment covered under this section as per Section 230500.

1.3 REFERENCE STANDARDS

- A. ASHRAE 70 – Method of Testing the Performance of Air Outlets and Air Inlets
- B. ASTM 610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
- C. ASTM 714 – Test Method for Evaluating Degree of Blistering of Paints
- D. ASTM D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- E. ASTM D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- F. ASTM D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub

PART 2 - PRODUCTS

2.1 MANUFACTURERS AND GENERAL REQUIREMENTS

- A. Products: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Grilles, Registers, and Diffusers
 - a. Anemostat Products: a Mestek company.
 - b. Carnes.
 - c. Hart & Cooley Inc.
 - d. Krueger.
 - e. Nailor.
 - f. Price Industries.
 - g. Shoemaker.
 - h. Titus.
 - i. Tuttle & Bailey.
 - 2. Thermal Displacement Diffusers
 - a. Price Industries

b. Titus

B. General Diffuser Requirements:

1. Devices shall be specifically designed for variable-air-volume flows.
2. Material: Steel or aluminum.
3. Finish: Baked enamel.

C. General Registers and Grilles Requirements:

1. Material: Steel or aluminum.
2. Finish: Baked enamel.
3. Damper Type: Adjustable opposed blade per Drawing schedule.

2.2 GRILLES AND REGISTERS

A. Adjustable Louvered Grilles and Registers

1. Description: Steel or aluminum louvered grille or register suitable for supply or return.
2. Construction
 - a. Steel
 - b. Single deflection or double deflection per the Drawings.
 - c. Supply Grilles:
 - i. Face Blades: adjustable horizontal or vertical spaced as scheduled on the Drawings.
 - ii. Rear Blades: adjustable horizontal or vertical spaces as scheduled on the Drawings.
 - d. Return Grilles:
 - i. One set of fixed deflection blades, deflection and spaces as scheduled on the Drawings.
 - e. Blade orientation: as scheduled on the Drawings.
3. Frame: Grilles are to be compatible with the ceiling type as scheduled on the Drawings and the architects Reflected Ceiling Plan.
4. Paint and Finish: as scheduled on the drawings.
5. Options: As scheduled on the drawings.
 - a. Opposed Blade Damper
 - b. Border: where grilles are smaller than the lay-in tile, the grille shall be mounted in a steel border of the same size as the ceiling. Paint and Finish to be same as grille.
 - c. Return air silencers.
 - d. Removable core with stainless steel quick-release fasteners.

2.3 CEILING DIFFUSERS

A. Square Plaque Ceiling Diffuser

1. Description: Square plaque diffuser for 360° radial, horizontal air delivery.
2. Construction:
 - a. Steel, consisting of a seamless, one-piece formed backpan with a round inlet collar.
 - b. Inner Plaque: Removable, installed no more than 1/4" below the ceiling plane
 - c. Face Panel: Smooth edged with rounded corners.
 - d. Diffusers are to be compatible with the ceiling type as scheduled on the

Drawings and the architects Reflected Ceiling Plan.

3. Paint and Finish: As scheduled on the Drawings.
 4. Options: As scheduled on the Drawings.
 - a. Steel Panel: where diffusers are smaller than the lay-in tile, the diffuser shall be mounted in a steel panel of the same size as the ceiling. Paint and Finish to be same as diffuser.
 - b. Damper:
 - i. Radial opposed blade damper.
 - ii. Full flow damper, duct mounted.
 - iii. Full flow damper, diffuser mounted.
 - iv. Radial damper, diffuser mounted.
- B. Louver Face Diffuser
1. Description: Modular louvered face ceiling diffuser, having fixed louvers capable of producing the airflow discharge pattern as indicated on the schedule on the Drawings.
 2. Construction:
 - a. Steel or aluminum construction.
 - b. Outer Frame Assembly: provide framing conducive to the ceiling type called out on the Drawings and the architects Reflected Ceiling Plan.
 - c. Collar: square or rectangular as indicated on the Drawings.
 - d. Inner Core: Fixed louvers for airflow discharge pattern control, pattern as indicated on the Drawings, fully removable for access to dampers and ductwork.
 - i. Core assemblies shall be identically constructed so that different directional assemblies may be provided and interchanged between frames without changing the entire diffuser.
 3. Paint and Finish: As scheduled on the Drawings.
 4. Mounting Frame:
 - a. Diffusers are to be compatible with the ceiling type as scheduled on the Drawings and the architects Reflected Ceiling Plan.
 5. Options: As scheduled on the Drawings.
 - a. Steel Panel: where diffusers are smaller than the lay-in tile, the diffuser shall be mounted in a steel panel of the same size as the ceiling. Paint and Finish to be same as diffuser.
 - b. High Induction Vanes
 - c. Adjustable pattern deflectors

2.4 ROOF HOODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
1. Acme Engineering & Mfg. Corporation.
 2. Carnes.
 3. Greenheck Fan Corporation.
 4. JencoFan.
 5. Loren Cook Company.
 6. PennBarry.
 7. Twin City Fan & Blower; Twin City Fan Companies, Ltd.
- B. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick

hood; suitably reinforced.

- C. Roof Curb: Required.
- D. Screen: Aluminum, 1/2" square mesh, 16 gauge wire.
- E. Finish: Baked-enamel finish; color as selected by Architect during shop drawings. Provide physical color chip for selection. Enamel finish to be grey.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions
- B. Install grilles, registers, and diffusers level and plumb.
- C. Install grilles, registers, and diffusers with an airtight connection to the duct system they serve, and to allow service and maintenance of any accessories, dampers, air extractors or fire dampers within.
- D. Install supply, return, and exhaust air grills/diffusers a minimum 3' away from all smoke/heat detection devices used in the fire alarm system. Field coordinate location of these devices with the pertinent contractors.
- E. Ceiling-Mounted Air Outlets and Inlets: The Drawings indicate a general arrangement of ducts, fittings and accessories. The locations of GRD elements shown on the Drawings are intended to achieve airflow pattern, air volume, noise criteria, throw patterns, and pressure drop design criteria. Place diffusers where indicated on the Drawings as much as is practical. If any other disciplines items or architectural feature interfere with the position or adversely affect the throw of a diffuser, notify the Architect/Engineer for a determination on final placement.
- F. For units installed within a lay-in ceiling tile, install the unit in the center of a manufacturer provided panel matching the construction, paint and finish of the unit. Size the manufacturer panel the same as the surrounding lay-in tile.

3.2 ADJUSTMENT

- A. General: Prior to Air Balancing, adjust all grille, register, and diffuser air patterns as indicated on the drawings, or as directed.

3.3 CLEANING

- A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

3.4 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction to ensure that, except for normal weathering, devices will be without damage or deterioration at time of substantial completion.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Furnace.
 - 2. Air conditioning components.
 - 3. Thermostats.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
- B. Operation and Maintenance Manuals: For equipment covered under this section as per Section 230500.

1.3 QUALITY ASSURANCE

- A. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- B. Motors: Comply with requirements in Section 230520 "General Motor Requirements."

1.4 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified period.
 - 1. Warranty Period: Not less than one year from the date of Substantial Completion.
- B. Furnace: Commencing on Date of Substantial Completion:
 - a. Furnace Heat Exchanger: 20 years.
 - b. Integrated Ignition and Blower Control Circuit Board: Not less than five years.
 - c. Draft-Inducer Motor: Not less than five years.
 - d. High-Efficiency Oil Furnace Burner: Not less than three years.
 - e. Refrigeration Compressors: Not less than 10 years.
 - f. Evaporator and Condenser Coils: Not less than Five years.

PART 2 - PRODUCTS

2.1 FURNACES, GAS-FIRED, CONDENSING

- A. Description: Factory assembled, piped, wired, and tested gas-fired, condensing furnaces; complying with NFPA 54.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Amana Heating & Air Conditioning; Goodman Manufacturing Company, L.P.
 - 2. American Standard Companies, Inc.
 - 3. Arcoaire Air Conditioning & Heating.
 - 4. Armstrong Air.
 - 5. Bryant Heating & Cooling Systems; Div. of United Technologies Corp.
 - 6. Carrier Corporation; Div. of United Technologies Corp.

7. Comfortmaker Air Conditioning & Heating.
 8. Heil Heating & Cooling Products.
 9. Lennox Industries Inc.
 10. Rheem Manufacturing Company; Air Conditioning Division.
 11. Ruud Air Conditioning Division.
 12. Tempstar Heating & Cooling Products.
 13. Trane.
 14. YORK; a Johnson Controls company.
- C. Cabinet: Steel, baked enamel finish.
1. Cabinet interior around heat exchanger shall be factory-installed insulation.
 2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
 3. Factory paint external cabinets in manufacturer's standard color.
- D. Fan: Centrifugal, factory balanced, resilient mounted, direct or belt drive.
1. Special Motor Features: Electronically controlled motor (ECM) controlled by integrated furnace/blower control.
- E. Air Filters:
1. Washable Filters: 1-inch-thick, urethane pad.
 2. Disposable Filters: 1-inch-thick fiberglass media in sheet metal frame.
 3. Provide three extra sets of filters.
 4. HEPA Air Filter Units: Sheet metal housing with fan arranged to be ducted to return-air duct connection to furnace, with activated carbon prefilter, high-efficiency particulate air (HEPA) disposable filter. HEPA shall be as follows:
 - a. Standard: UL 586, "High-Efficiency, Particulate, Air Filter Units."
 - b. Rating: ASHRAE 52.1, dust-spot efficiency of 65 percent; ASHRAE 52.2, 99.97 percent efficiency to 0.03-micrometer particle size.
- F. Type of Gas: Natural.
- G. Heat Exchangers: Stainless steel.
- H. Burner:
1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
 2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
- I. Gas-Burner Safety Controls:
1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
 2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
 3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- J. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.
- K. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds;

adjustable fan-on and fan-off timing; terminals for connection to accessories.

1. Thermostat: Wall mounted, single stage, heating and cooling.

2.2 AIR CONDITIONING COMPONENTS

A. General Refrigeration Component Requirements:

1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

B. Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet.

1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
2. Drain Hose: For condensate.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Air-Cooled, Compressor-Condenser Unit:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed reciprocating or scroll type.
 - a. Crankcase heater.
 - b. Vibration isolation mounts for compressor.
 - c. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - d. Two-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
4. Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
5. Fan: Aluminum-propeller type, directly connected to motor.
6. Motor: Permanently lubricated, with integral thermal-overload protection.
7. Low Ambient Kit: Permits operation down to 45 °F.
8. Mounting Base: 12" minimum condenser stand.

2.3 THERMOSTATS

A. Solid-State Thermostat: Furnace F-1

1. Type: Wall-mounting, programmable, microprocessor-based unit.
2. Heat/Cool Switching: Automatic.
3. Exposed set point.
4. Exposed indication.
5. Deg F indication.
6. Battery backup protection against power failure for program settings.
7. Programmability: Seven-day with minimum of four temperature presets per day.

- B. Two-Stage, Heating-Only Thermostat: Furnace F-2
 - 1. Heat-Off switch.
 - 2. Fan on-Auto switch.
 - 3. Exposed set point.
 - 4. Exposed indication.
 - 5. Deg F indication.
- C. Control Wiring: Unshielded twisted-pair cabling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions
- B. Install gas-fired furnaces and associated fuel and vent features and systems according to NFPA 54.
- C. Suspended Units: Suspend from structure using threaded rods, spring or elastomeric hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
- D. Controls: Install thermostats at mounting height of 48 inches above floor to center of device.
 - 1. Line voltage thermostats installed by Electrical Contractor.
- E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.
- F. Install ground-mounted, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of gas piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Install condensate drains to indirect waste. Provide neutralizer for condensate from flue.
- D. Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
 - 1. Slope pipe vent back to furnace or to outside terminal.
- E. Connect ducts to furnace with flexible connector. Comply with requirements in Section 233100.
- F. Connect refrigerant tubing to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.
- G. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum

heating performance and system efficiency.

- H. Install new filters in each unit within 14 days after Substantial Completion.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Infra-red tube heaters, gas-fired.
 - 2. Thermostats.

1.2 SUBMITTALS

- A. Shop Drawings: For equipment covered under this section as per Section 230500.
 - 1. Include rated capacities, operating characteristics, and accessories.
 - 2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Wiring Diagrams: Power and control wiring.
- B. Operation and Maintenance Manuals: For equipment covered under this section as per Section 230500.

1.3 QUALITY ASSURANCE

- A. Motors: Comply with requirements in Section 230520 "General Motor Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Tube heaters shall be certified to the ANSI Z83.20 standard and bear the CSA certification label.

1.4 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified period.
 - 1. Warranty Period: Not less than one year from the date of Substantial Completion.
- B. Tube heaters:
 - 1. Tube Exchangers: Not less than five years from the date of Substantial Completion.
 - 2. Burner: Not less than ten years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INFRA-RED TUBE HEATERS, GAS-FIRED

- A. Description: Gas-fired, low intensity tubular radiant heaters.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or other prior approved:
 - 1. Detroit Radiant Products Company.
 - 2. Roberts Gordon.

- C. Gas and Fan Control: Two-stage.
 - 1. Staging: Minimum differential of 30% between high and low input modes.
- D. Combustion Chamber: 4 inch O.D. tube finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level of .92 or higher.
 - 1. 150-200 MBH Units: 16ga. Titanium stabilized aluminized steel.
 - 2. Below 150 MBH Units: Aluminized steel
- E. Emitter Tube: 4 inch O.D. 16ga. aluminized steel finished with a high emissivity rated, corrosion resistant, black coating with an emissivity level documented at .92 or higher.
 - 1. Harsh/Humid Environments: 304 grade stainless steel.
 - 2. Tube Connections: 4 inch slip-fit, interlocking connection in which the upstream tube slides into the next tube and is held by a bolted clamp.
 - 3. Downstream Turbulator Baffle: Provide.
- F. Appliance Type: Positive pressure power burner with a combustion fan upstream of the burner and exhaust gases. Negative pressure (pull through) type appliances are not allowed.
- G. Combustion Fan:
 - 1. Impeller: Balanced.
 - 2. Motor: Permanent-split capacitor with sealed bearings, thermally protected.
 - 3. Enclosure: Housed inside burner control box.
- H. Burner: Stainless-steel venturi burner.
 - 1. Flame Anchoring Screen: Minimum temperature rating equivalent to that of 304 grade stainless steel.
 - 2. Ignition System: Hot surface silicon carbide.
 - 3. Sight Glass: Allow visual inspection of igniter and burner operation from floor.
- I. Reflectors: .025 inch polished aluminum with a multi-faceted design; include reflector end caps; rotatable from 0 to 45 degrees.
 - 1. Finish: Polished with clear visual reflection ability.
 - 2. Profile: Optimized for downward radiation.
 - 3. Hanging System: Permit expansion while minimizing noise and/or rattles.
- J. Control Box: Constructed of corrosion resistant enameled steel; serviceable while heater is operating.
 - 1. Harsh Environments: Silicone sealed housing.
 - 2. Air intake: Integral to burner control assembly to accept a 4 inch O.D. supply duct.
 - 3. Indicators: Verify air flow, validate gas valve operation.
- K. Burner Safety Controls:
 - 1. Safety differential pressure switch to monitor combustion air flow.
 - 2. Shut off the gas flow to the main burner in the event either a gas supply or power supply interruption occurs.
 - 3. 50 second pre-purge and 90 second post-purge.
- L. Venting: Shall be per the manufacturer's approval and specifications.

2.2 THERMOSTATS

- A. Two-Stage, Heating-Only Thermostat:
 - 1. Heat-Off switch.
 - 2. Fan on-Auto switch.
 - 3. Exposed set point.
 - 4. Exposed indication.
 - 5. Deg F indication.
- B. Control Wiring: Unshielded twisted-pair cabling.

PART 3 - EXECUTION

3.1 RADIANT TUBE HEATER INSTALLATION

- A. Install and connect gas-fired radiant heaters, associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Suspended units: suspend from substrate using chain hanger kits and building attachments.
- C. Maintain manufacturers' published clearances to combustibles.
- D. Adhere to manufacturers' installation instructions.
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- F. Replace damaged and malfunctioning controls and equipment.
- G. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gas-fired radiant heaters.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of gas piping, fittings, and specialties. Connect gas piping with union or flange and appliance connector valve.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater.
- D. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

END OF SECTION

VALVOLINE INSTANT OIL CHANGE
WILLISTON, NORTH DAKOTA
PROJECT # 26012

DIVISION 26 – ELECTRICAL

SECTION 260500	COMMON WORK RESULTS FOR ELECTRICAL
SECTION 260505	TEMPORARY FACILITIES AND CONTROLS
SECTION 260519	CONDUCTORS
SECTION 260526	GROUNDING
SECTION 260533	RACEWAYS
SECTION 260534	OUTLET, PULL AND JUNCTION BOXES
SECTION 260553	IDENTIFICATION
SECTION 260583	CONNECTIONS TO EQUIPMENT
SECTION 262416	PANELBOARDS
SECTION 262713	ELECTRIC SERVICE
SECTION 262726	WIRING DEVICES AND DEVICE PLATES
SECTION 262813	FUSES
SECTION 262816	ENCLOSED SWITCHES & CIRCUIT BREAKERS
SECTION 264313	SURGE PROTECTION DEVICES
SECTION 265100	LUMINAIRES
SECTION 266510	OVERHEAD DOOR WIRING
SECTION 266530	ELECTRIC HEATING EQUIPMENT

DIVISION 27 – COMMUNICATIONS

SECTION 270500	DIVISION 27 GENERAL PROVISIONS
SECTION 270528	NETWORK SYSTEMS ROUGH-IN
SECTION 271513	NETWORK CABLING
SECTION 274133	TV SIGNAL CABLING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Specification Format

1. These Specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractors, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "the Contractor shall", and "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, perform all indicated requirements whether stated imperatively or otherwise.
2. Three Part Format
 - a. "Part 1.0 - General": Covers those areas which relate to the Work, and which define the general administrative and technical requirements specific to a particular section.
 - b. "Part 2.0 - Products": Defines, in detail, the acceptance equipment and materials to be incorporated into the Work.
 - c. "Part 3.0 - Execution": Describes, in detail, the manner in which items covered by Part 2 are to be incorporated into the Work.
3. Where Codes, Specifications and Drawings are in conflict, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies immediately to the Engineer prior to commencing related work.

B. Definitions

1. "Furnish" - Supply equipment as required by these Drawings and Specifications, delivered to the job site for installation or use by others.
2. "Install" - Fix in position for total operational use all apparatus as shown, specified or required. Provide all miscellaneous fittings and wiring supplies.
3. "Or Approved Equal" - Equipment or materials selected by Contractor subject to Engineer's acceptance.
4. "Or Equivalent" - Equipment or materials selected by Contractor matching the function and performance of equipment or materials listed.
5. "Provide" - Furnish and install in place, total and operational.
6. "Manufacturer's Representative" – person properly trained/certified for the specific equipment and a regular employee of the Manufacturer, the Manufacturer's Representative Agency, a third party specializing company, or the selling distributor.
7. "Substantial Completion" - The date when the project has been completed, inspected, and accepted by the Engineer and Owner.

C. Work Included

1. Provide labor, equipment and materials in connection with Work specified and shown on Drawings.
2. Work of this Division is subject to requirements of Instructions to Bidders, General Conditions, Supplementary Conditions, Division One, and all other sections of this Specification.
3. Examine site and all Contract documents prior to submittal of bid.

D. Work Installed But Furnished Under Other Directives

1. Provide service for electrically operated equipment not specified in Division 26 & 27. Verify size and locations of such connections by securing all rough-in requirements from the equipment supplier.
2. Equipment requiring electrical service shall be furnished with motors, special controls and remote electrical devices as specified in other Divisions.
3. Verify extent of controls and devices furnished by referring to Divisions where Work is specified.
4. Provide disconnects, starters, control devices, thermal units, fuses, switches and all necessary power and control wiring. Include the installation of remote electrical devices furnished separately with the equipment. Provide identification for remote devices as directed by the Engineer.
5. Contractors of other Divisions providing electrically operated equipment shall verify with the Electrical Contractor the proper voltage and phase before releasing equipment for shipment.
6. Unless otherwise specified, Contractor responsible for furnishing such equipment is also responsible for setting in place.

1.2 ALTERNATES

A. General

1. The work of this Section is affected by the Alternates described in this Specification.

B. Alternate E-1

1. The Owner wishes to know in advance the possible cost to
2. Base Bid:
3. Under Alternate Bid E-1 on the Bid Form, state the Contract Sum to

1.3 CONTINGENCY

- A.** Use contingency only on issuance of Change Orders.
- B.** Refer to Division 1 for the amount to include in the Electrical Bid.
- C.** Money remaining in contingency at close of project will be credited to the Owner by Change Order.

1.4 SUBMITTALS

A. Substitution and Prior Approval to Quote.

1. The reference to manufacturer's name and catalog or model numbers shall be interpreted as establishing a standard of quality, not as limiting competition.

2. Suppliers wishing to price material or equipment not referenced in Specifications or on Drawings shall apply in writing to Engineer for approval to quote. Electronic submittals shall be in PDF format. Include complete descriptive technical data on the proposed item consisting of: model numbers, type, size and performance characteristics. Procedure also applies to requests by Contractor. Self-addressed, stamped envelope required for return reply.
3. The request for prior approval to quote shall be received in Engineer's office no later than 192 hours (eight days) prior to bid opening. All substitute items approved for quotation will be listed in Addenda sent to all planholders in advance of bid opening.
4. Contractors choosing to use material or equipment other than those shown on Drawings or specified in detail, but approved for quotation, shall be responsible for physical dimensions and coordination. Architect, Engineer, or Owner will not be responsible for costs of necessary changes and additional work required by Contractor or any other trades.
5. Substitutions will not be permitted after bid opening.

B. Correspondence

1. Direct all correspondence concerning Division 26 & 27 submittals to:

THOMAS KEELING, P.E.
PRAIRIE ENGINEERING, P.C.
1905 17TH ST SE
MINOT, ND 58701
tkeeling@prairieengineeringpc.com

C. Shop Drawings

1. Before any of the materials are delivered to the job, submit to Engineer via the Prime Contractor complete Shop Drawings for each item indicated.
2. Include catalog numbers, performance data, dimensions and other descriptive information.
 - a. The actual part numbers and options for equipment to be utilized shall be highlighted to indicate exact equipment to be furnished.
 - b. Only include information relevant to the equipment being provided. Any extraneous materials shall be removed prior to submittal.
3. Shop Drawings shall be in electronic PDF format and shall include catalog sheets showing all necessary information. Shop drawings shall be separated by specification section, and equipment from separate specification sections shall not be combined.
4. Shop Drawings shall be submitted under the appropriate specification section of the electronic submittal service being used. The shop drawing file for each section shall include the specification section number, section name, and revision number. Example: "262726 Wiring Devices REV 01".
 - a. If an electronic submittal service is not being used, shop drawings may be emailed to the Engineer at the email address indicated above. Emailed shop drawings shall not exceed 10 MB. If shop drawings exceed 10 MB, contact the Engineer to arrange for a file transmittal method.

5. Each Shop Drawing folder shall be **stamped, initialed, and dated**, on a cover sheet included in the PDF submittal by Division 26 Contractor to indicate they have thoroughly reviewed them in accordance with General Conditions. **Email message text not acceptable.**
 - a. If the Division 26 contractor is under a Prime Contractor, the Prime Contractor may also include a review stamp. However this does not relieve the Division 26 contractor from applying their review stamp.
6. Shop Drawings not in conformance with Specification will be returned to Prime Contractor without review.
7. A maximum of two reviews will be completed for each section. Additional submittals required due to lack of proper corrections being made may be subjected to review fees from the Engineer billed to the Division 26 contractor.

D. As-Built Drawings

1. Designate one set of clean blueprints at project site as As-Built Drawings. Make As-Built Drawings available to Engineer during project visitation.
2. As work progresses, Contractor's field supervisor shall mark As-Built Drawings in red pencil to indicate actual conditions of installation.
3. Show same general details as Drawings.
4. Give particular attention to marking actual locations of feeders and underground runs.
5. Affix all addendum and change order descriptions to appropriate as-built drawing sheet, utilizing spray adhesive.
6. Submit As-Built Drawings to Engineer along with Record Manuals at close of project in PDF format.
 - a. As-Built Drawings shall be submitted as one PDF file.
 - b. Record Manuals shall be submitted as one PDF file.
7. Provide minimum one hard copy of As-Built Drawings to the Owner.
8. Review Division 1 for additional requirements for hard copies of As-Built Drawings.

E. Record Manuals

1. Upon completion of Work of this Division and as condition of its acceptance, Contractor shall compile Record Manuals.
 - a. List project name, date, Contractor's name, address and telephone number on exterior label of each Record Manual.
 - b. Provide one electric PDF copy to Engineer for review.
 - 1) After electronic PDF copy is reviewed and approved, provide one hard copy of Record Manual to Owner. Include an index sheet indicating each major piece of equipment, supplier and supplier's telephone number. Provide tabbed dividers indicating major groupings of equipment.
 - 2) Review Division 1 for additional requirements for hard copies of Record Manuals.
 - c. Record Manual information shall be included for all equipment/material where Shop Drawings are required. **Also include all installation, operation and maintenance data packaged with any equipment.**
2. Turn over to Owner all spare equipment and devices specified and shown. List quantities on contractor letterhead or invoice, obtain signature of Owner's representative acknowledging receipt, and include with each Record Manual.

3. Include one copy of formal instructional recordings, properly identified as to specification section.
4. Include copy of State Electrical Board Wiring Certificate in each Record Manual.
5. Include service equipment fault current calculation and step-down transformer fault current calculations in record manuals. Utility transformer fault current shall be calculated per Section 260553-3.3. Step-down transformer fault current shall be calculated per Section 262200-1.2. Provide in tabular form, as per the following example:

Transformer	kVA	Sec. Voltage	Phase	Impedance	Fault Current	Date Calculated
Utility	300	480	3	1.06%	34,043 amps	11/15/2016
T-1	150	208	3	3.8%	10,958 amps	11/15/2016

6. Calculate the available fault current (AFC) for the mechanical and electrical equipment listed and provide the information in tabular form, utilizing naming convention on the drawings.
 - a. HVAC Equipment 1HP and larger
 - b. Refrigeration Equipment
 - c. Elevator Equipment
 - d. Industrial Control Panels
 - e. Electrical Distribution Equipment
 - f. Branch Panelboards
 - g. MCC's.

7. Fault Current Table Format Example:

Equipment	Voltage	Phase	AFC at Equip.	Date Calculated
<u>AH-1</u>	480	3	5,289 amps	11/15/2016
<u>CU-1</u>	208	3	2,321 amps	11/15/2016

8. Transformer fault current table and equipment fault current calculation table shall be grouped together in the same tabbed section of the record manuals.

1.5 QUALITY ASSURANCE

A. Qualifications of Installers

1. For installation and testing, use only trained licensed and experienced workmen familiar with items required and manufacturer's recommended methods.
2. In acceptance or rejection of installed work, no allowance will be made for lack of skill on the part of the workmen.
3. To the maximum extent possible, retain the same supervisory personnel throughout the duration of the Work.

B. Licenses, Permits, Codes and Standards

1. Materials, workmanship and installation: comply with the latest editions of all applicable codes, local ordinances, industry standards, utility company regulations, insurance carrier requirements and these Specifications.
2. Codes and standards shall include, but not necessarily be limited to, the following:

- a. Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL)
 - b. National Electrical Code (NEC)
 - c. National Fire Protection Association (NFPA)
 - d. Occupational Safety and Health Act (OSHA)
 - e. State and local wiring standards
 - f. Building and fire codes
3. The more stringent provisions shall govern where provisions of pertinent codes and standards conflict with these Specifications or Drawings. Where Codes, Specifications or Drawings differ with one another, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies to the Engineer immediately.
4. Pertinent codes and standards shall not be cited to furnish less than specifically shown or specified.
5. Obtain and pay all permits, inspections, licenses and other charges pertaining to the Work. Upon completion of the Work, furnish proof of acceptance by proper agency having jurisdiction.

1.6 GUARANTEE AND WARRANTY

- A. Unless otherwise modified by other sections of this specification, contractor shall guarantee materials, workmanship and the proper operation of equipment for a period of one year. Warranty period shall begin at date of substantial completion, or date of specific equipment commissioning, whichever is later. Contractor shall correct all equipment, material and workmanship found to be defective or non-conforming to the contract documents without cost to Owner.
- B. Guarantee shall include trips to the project site by Contractor to adjust electrical equipment as required, ensuring it is operating as intended.
- C. Specified guarantee shall not relieve Contractor from liability arising from improper installation or non-compliance with applicable codes.
- D. Contractor shall include written warranty statement, indicating start and end dates of warranty period. Warranty statement shall be included with each copy of the Record Manuals.

1.7 CHANGES TO CONTRACT

- A. Any required changes to the contract after bid date shall be in accordance with General Conditions/Division 1 and this section. Where any discrepancies between the sections are encountered, the more restrictive section shall apply.
- B. Proposed changes shall be accompanied with complete substantiating documentation.
 1. Provide an itemized list of quantities for materials, equipment, and supplies.
 - a. Include unit costs for each item and extended price.
 - b. Include unit labor for each item and extended time.
 2. Provide subcontractor proposals that include the same substantiating documentation.
 3. Provide quotations from suppliers for any specially ordered equipment.

- C. Material costs shall be actual costs to the contractor, obtaining the materials through normal supply channels, including trade and quantity discounts. Utilizing “suggested pricing” from national pricing organizations for unit costs shall not be accepted. Upon request, the contractor or subcontractor shall submit evidence to substantiate the costs.
- D. Labor units shall be industry accepted standard labor hours to perform one unit of work. If the work is being performed in a location that is not considered to be standard working conditions for that specific task, additional labor shall be itemized.
- E. Labor rates shall be the actual rate paid for the workman category along with associated labor burden. Labor burden shall consist only of the mandatory fringe benefits, labor taxes, and labor insurances as affected by payroll. The owner reserves the right to reject any labor burden which is inconsistent with other similar contractors or where the fringe benefit cost is in excess of established labor agreements.
- F. Allowable markups for contractor and subcontractors
 - 1. Overhead on work performed by own forces: Refer to Division 1.
 - 2. Profit on work performed by own forces: Refer to Division 1.
 - 3. Commission on work performed by Subcontractors: Refer to Division 1.
 - 4. Sales tax.
 - 5. Bond and permit increases where applicable.
- G. No additional markups shall be allowed for:
 - 1. Field and/or office supervision/administration time.
 - 2. Tool burden.
 - 3. Shop burden.
 - 4. Overhead/Profit applied to work performed by others.
- H. Additional costs for travel and subsistence shall only be allowed if the proposal includes a request for extension of the completion date. Furthermore, those costs shall be proportional to the number of working days of the extension.
- I. Subcontractors shall compute their costs in the same manner as the contractor. Subcontractors are subject to the same markup constraints as described herein.
- J. For changes resulting in credit to the costs, no restocking fees for materials shall be applied by the contractor or subcontractors.

1.8 TEMPORARY FACILITIES

- A. Refer to Special Conditions and/or Division 1 for details of temporary facilities.

1.9 APPLICATIONS FOR PAYMENT

- A. Refer to Division 1 “Applications for Payment”.
- B. Provide one additional copy, sent directly to the Engineer.

C. Format and content:

1. When included with the Bid, the following categories shall be indicated on the application for payment:
 - a. Project mobilization.
 - b. Demolition.
 - c. Service & Distribution (all switchgear, panels, transformers, motor control centers, and loose control/disconnects, installed in place).
 - d. Lighting (all fixtures and lamps, installed in place, including pre-fabricated wiring system).
 - e. Wiring Devices (all switches, receptacles, and plates, except voice-data, installed in place).
 - f. Equipment Connections (HVAC, elevator, food service, etc, connected in place).
 - g. Basic Materials (all conduit, wire, boxes, supports, fittings, grounding materials, except special systems and voice-data cabling systems, installed in place).
 - h. Fire Alarm & Detection (all system equipment, installed in place).
 - i. Special Systems (all system equipment and cabling, installed in place, broken out by Specification Section. Examples include Clock and Program, Intercom, Nurse Call, Public Address, Sound Reinforcement, Rescue Assistance, TV Signal Cabling, Architectural and Theatrical Lighting Controls, and the like).
 - j. Generator (all system equipment, installed in place).
 - k. Voice-Data Cabling Systems (all system equipment, installed in place).

PART 2 – PRODUCTS

2.1 MATERIAL

- A. Material and equipment shall be as shown or specified. Provide material not specifically described but required for a complete and proper installation of the Work, subject to the acceptance of the Engineer.
- B. All material and equipment shall be new when delivered to the job and be listed by a Nationally Recognized Testing Laboratory (NRTL).
- C. Owner will not be liable for material installed in non-compliance with codes, standards, and these Contract Documents.

2.2 PRODUCT HANDLING

- A. Protection
 1. Use all means necessary to protect the materials of this Division before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements
 1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

PART 3 – EXECUTION

3.1 GENERAL

- A. Engineer, Architect, or Owner shall not be responsible for the means, methods, techniques, sequences or procedures of construction selected by Contractor.
- B. Engineer, Architect, or Owner shall not be responsible for safety precautions and programs incidental to work of Contractor.
- C. It is the sole responsibility of Contractor to initiate, maintain, and supervise all safety precautions and programs in connection with the Work.

3.2 SURFACE CONDITIONS

- A. Prior to work of each Section of Division 26 & 27, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that work of this Division may be installed in accordance with all pertinent codes, regulations and standards.

3.3 COORDINATION

- A. Order material in a timely fashion to assure it is on the job site when required.
- B. Coordinate installation of material with schedule of other trades to prevent unnecessary delay in construction schedule.

3.4 DISCREPANCIES, CONSTRUCTION CONFLICTS AND DRAWINGS

- A. Discrepancies
 - 1. Prior to submitting bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification.
 - 2. The Architect, Engineer or Owner will not be responsible for any oral instructions or modifications to the contract documents prior to opening of bids.
 - 3. Written interpretation or clarification will be made by Addenda.
- B. Construction Conflicts
 - 1. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision.
 - 2. Do not proceed with installation in area of question until conflict has been fully resolved.
 - 3. When so directed by Engineer, Contractor shall make minor adjustment to avoid interferences with other trades. Such minor adjustments shall be performed at no additional cost to the Architect, Engineer or Owner.

C. Drawings

1. Drawings indicate extent and general layout of electrical systems for project. Due to small scale, it is not possible to indicate all fittings and accessories that may be required. Provide such fittings and accessories as required to form a complete and operating system in general conformance with Specifications and Drawings.
2. Data indicated on Drawings and in these Specifications is as exact as could be secured, but absolute accuracy is not guaranteed.
3. Exact locations, distances, levels and other conditions will be governed by the structure. Field measurements shall take precedence over the Drawings. Use the Drawings and these Specifications for guidance. Secure the Architect's approval for all changes in locations.
4. Verify all measurements at site. No compensation will be made because of difference between locations shown on the Drawings and measurements at the building.
5. Refer to the architectural drawings for dimensions and locations of walls, partitions, doors, windows, ceiling heights, door swings and other details of construction.

3.5 UNDERGROUND UTILITIES

- A. Locations of existing underground utilities are based on available site information and are shown approximately. Contractor shall determine exact utility locations before commencing work and shall be responsible for repair of damages resulting from his construction activities.
- B. Trench and backfill for installation of underground conduits to depth shown or required. Remove any accumulated water in excavation by pumping. Shore and brace excavation as required by safety regulations. Provide temporary bridges to maintain normal traffic flow. Excavation and backfill required by electrical installations shall be accomplished in accordance with Earthwork Specifications by this Contractor.

3.6 CUTTING AND PATCHING

- A. Carefully lay out all work in advance to minimize cutting, channeling or drilling.
- B. Where necessary, all such cutting and patching shall be done in a manner approved by Architect.
- C. Restore damaged surfaces to their original condition by skilled mechanics of the trade involved. Contractor at fault shall assume all cost.
- D. Use only rotary type drilling tools to cut concrete.
- E. Do not endanger the stability of the structure. Do not at any time cut or alter work of any other Contractor without Architect's consent.

3.7 TESTS

- A. Perform all tests as required by Engineer during construction and as described in other Sections of these Specifications.
- B. Testing of entire installation shall be completed before final inspection.

3.8 INSTRUCTIONS

- A. After all required approvals of the Work have been obtained; demonstrate the operation and maintenance of all electrical equipment to the Owner's personnel.
- B. Provide written and oral operating and maintenance instructions to Owner's representatives. The oral instructions shall be given before the Owner occupies the buildings. Instructions to include all building's electrical systems and equipment.
- C. Copies of written operating and maintenance instructions shall be included with each Record Manual.
- D. Electrical Contractor shall coordinate with Owner at Owner's convenience, formal instruction time for contractor personnel to instruct Owner's Representatives on all equipment. Provide similar equipment supplier's instructions where specified thus. Formal instruction to occur with each Record Manual, being referenced to and a part of the Manual.
- E. Formal instructions shall be recorded when required by other Sections of this Specification by this Contractor. Format shall be digital media capable of being played on Windows or Mac operating systems, or shall be submitted on a USB storage device.
 - 1. Electronic PDF files for the as-built drawings and record manuals shall also be included on the USB storage device with the formal instructions.

3.9 CLEAN UP

- A. Remove all scrap material left on job during and after installation of Work.
- B. All equipment having finished paint surfaces shall be examined upon completion for scratches and other damage. Touch up all surfaces as required with paint of color to match factory finish.
- C. Perform all cleaning as required by other Sections of Division 26 & 27.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Temporary electricity.

1.2 PRODUCT HANDLING

A. Protection

1. Use all means necessary to maintain temporary facilities and controls in proper and safe condition throughout the progress of Work.

B. Replacements

1. In the event of loss or damage, immediately make all repairs and replacements necessary at no additional cost to Owner.

PART 2 – PRODUCTS

2.1 UTILITIES

A. Temporary Facilities

1. General: all costs, including utility company charges, required for the performance of temporary electrical system, shall be paid by Electrical Contractor.
2. Energy charges: Refer to Division 1 for requirements.
3. Temporary Electricity: Electrical Contractor shall:
 - a. Furnish and install all necessary temporary wiring.
 - b. Provide area distribution boxes located so the individual trades may use their own construction type extension cords.
 - c. Provide GFCI protection on all temporary power per NEC.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide a complete system of conductors enclosed in a raceway.

1.2 SUBMITTALS

A. Record Drawings

1. Maintain accurate record drawings in accordance with Section 260500.

PART 2 – PRODUCTS

2.1 CONDUCTOR

A. Copper

1. Soft drawn, annealed.
2. Conductivity of not less than 98% pure copper.
3. Insulated for 600 volt service.
4. #10 AWG and smaller: Solid, THWN/THHN.
5. #8 AWG and larger: Stranded, THWN/THHN.
6. Provide USE where required by Code.

B. MC Cable

1. MC cable is not acceptable for use as a wiring method.

2.2 SPLICES

- A. #10 AWG and smaller: Scotchlock Y, R or G as manufactured by 3M Company, or equivalent.
- B. #8 AWG and larger: Compression type, as manufactured by Anderson, Burndy, Thomas and Betts Company, or equivalent.

2.3 LUBRICANT

A. General

1. NRTL-listed.
2. Flame resistant
3. Compatible with conductor insulation.

B. Acceptable Manufacturer

1. As selected by Contractor.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with Code, product listing, and manufacturer's recommendations.
2. Install wire and cable in Code-conforming raceways after moisture and debris is swabbed from conduit.
3. Refer to system specified for conductor's peculiar to that system.
4. Conductor sizes: Standard AWG, #12 minimum unless otherwise indicated.
5. Fixture taps: minimum #16 AWG.
6. Conductor temperature ratings: Compatible with the equipment to which it is to be connected. Refer to product listing.
7. Make conductor length for parallel feeders identical.
8. Derate ampacities as required for high ambient temperatures or conductor fill.

B. Color

1. Multi-wire (shared neutral) circuits.
 - a. 120/208 volt
 - 1) Phase conductors: Black, red or blue.
 - 2) Grounded conductor (neutral): White.
 - 3) Grounding conductor: Green or bare.
2. Separate neutral circuits:
 - a. 120/208 volt
 - 1) Phase conductors: Black, red or blue.
 - 2) Grounded conductor (neutral): White with stripe colored to match phase.
 - 3) Grounding conductor: Green or bare
3. Switch legs: Same as phase conductors.
4. 120 volt isolated ground circuits:
 - a. Phase conductor: Orange.
 - b. Grounded conductor (neutral): White with orange stripe.
 - c. Grounding conductor: Green with yellow stripe.

C. Splices

1. Eliminate wherever possible.
2. Made only at outlet or junction boxes.
3. Obtain special permission from Engineer for any splices in feeder conductors.

D. Voltage Drop

1. Increase size of circuit wiring in accordance with NEC 210.19(A)(1), fine print note, No. 4.
2. Use #10 AWG minimum for all home run conductors longer than 75 feet on 120/208/240 systems and 150 feet on 277/480 systems.

3.2 TESTS

- A. After equipment and wiring is installed, and before it is energized, test all power circuits with a megohmmeter for insulation resistance, phase-to-phase and phase-to-ground faults.
- B. Before testing, disconnect all equipment that might be damaged by the test voltages.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Bond and ground all electrical equipment in accordance with National Electrical Code, State/Local Codes, these Specifications and as shown on Drawings.

B. Description of System

1. The service equipment, conduit systems, supports, cabinets and neutral conductor shall be solidly grounded and bonded in accordance with National Electrical Code to form a permanent effective and continuous grounded system.

PART 2 – PRODUCTS

2.1 GROUND RODS

- A. Steel with a metallically bonded outer layer of electrolytically applied copper.
- B. Minimum 1/2" diameter 10 foot length, unless otherwise indicated.
- C. Sectional rods not permitted.
- D. Manufacturer: ERITECH or equivalent.

2.2 GROUND ROD CLAMPS

- A. Ground rod clamps shall be high strength silicone bronze.
- B. Manufacturer: ERITECH or equivalent.
- C. At Contractor's option, exothermic welding (CADWELD) or impact compression (ERITECH Hammerlock) may be used in place of ground rod clamps.

2.3 WATER PIPE GROUND CLAMPS

- A. Steel U-bolt with bronze saddle.
- B. Thomas and Betts Company 3900 series or equivalent.

2.4 REBAR GROUND CLAMPS

- A. Bronze alloy construction.
- B. Sized as required by rebar stub out.
- C. Eritech RC or EK series as required by local authority. Equivalent products by Thomas and Betts acceptable.

PART 3 – EXECUTION

3.1 GENERAL

- A. **Grounding conductors not shown or included on floor plans.**
- B. **When required, increase trade size of raceway accordingly.**
- C. Aluminum not acceptable for use as a grounding conductor.

3.2 SYSTEM GROUNDING

- A. Provide grounding electrode system in accordance with NEC 250.50. If available, each of the items listed in 250.52(A)(1) through (A)(8) shall be bonded together to form grounding electrode system.
- B. Connect grounding electrode conductor to grounded service conductor.
- C. Provide raceway enclosing grounding electrode conductor. If metallic, bond as per NEC 250.64(E). Provide grounding bushing as required complete with jumpers same size as grounding electrode conductor.
- D. To comply with NEC 250.53, provide two ground rods spaced minimum 6'-0" apart.

3.3 EQUIPMENT GROUNDING CONDUCTOR

- A. Non-metallic conduit: Sized in accordance with NEC, except as further modified by this Specification.
- B. Flexible Metal Conduit, Liquidtight Flexible Conduit.
 - 1. Other than for connection of 120 volt recessed luminaires, not acceptable for use as means of grounding.
 - 2. Provide bonding jumper sized in accordance with NEC around all flexible conduits. Use fittings having lugs for termination of jumper.
 - 3. Spiral wrap not acceptable. Lay along surface, secured with cable ties.
 - 4. Bonding jumper maximum length: 6'.
 - 5. Bonding jumper not required where separate equipment grounding conductor is used.
- C. Branch Circuits
 - 1. **Separate equipment grounding conductor required for each raceway.**
 - 2. Size: per NEC 250.122.
 - 3. Bond to grounding bars, junction boxes and luminaire grounding screws.
 - 4. Field install grounding screw in luminaire if not provided by factory.
- D. Feeders
 - 1. **Separate grounding conductor required.**
 - 2. Bond to grounding bars in switchboards, panelboards and motor control centers.

3. Provide grounding bushing at both ends of all feeders utilizing metallic raceway.
 - a. Bond to grounding bars at both ends.
 - b. Size bonding jumpers to match equipment grounding conductor.
 4. Feeder Equipment Grounding Conductor Size:
 - a. Size per NEC 250.122.
 - b. Copper equivalent ampacity when aluminum phase conductors utilized.
 5. Do not splice grounding conductor.
- E. Water Pipe System
1. Bond interior metal water piping per NEC Section 250.104(A) if water pipe system is not used as part of grounding electrode system.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide all conduit systems as shown on Drawings or required by Codes and Specifications.

B. Description of System.

1. Provide code-conforming raceway system for all conductors unless specifically noted otherwise by phrase "not in conduit".

1.2 SUBMITTALS

A. Record Drawings

1. Maintain accurate record drawings for all raceway runs in accordance with Section 260500.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Metallic conduit and tubing: Allied Tube and Conduit, Republic Conduit, or equivalent.

B. Non-metallic conduit: Carlon Schedule 40 or Schedule 80 where required, Allied Tube and Conduit, Cantex Inc., or equivalent.

C. Flexible metal conduit: Aluminum.

D. Liquidtight, flexible metal conduit: Anaconda Sealtite or equivalent.

E. Fittings

1. Rigid metal conduit: Appleton, Crouse-Hinds, or equivalent. **Pot metal conduit fittings not acceptable.**

2. EMT:

- a. **Steel.**

- b. Setscrew or watertight as required.

- c. Thomas and Betts Company, or equivalent.

- d. **Pot metal, "Sock-on" and indenter fittings not acceptable.**

3. Flexible metal conduit: STEEL, Thomas and Betts Company XC-400 series, or equivalent.

4. Liquidtight flexible metal conduit:

- a. **Steel.**

- b. Straight or angled as required.

- c. Appleton, Thomas and Betts Company or equivalent.

F. Hangers and Supports

1. As required by Codes and Specifications.
2. Raco, Unistrut, or equivalent.
3. Erico conduit clips, Type 8-M, 12-M and K-8 acceptable for individual branch circuit runs.

G. Metal Surface Raceway

1. Wiremold 500/700 metallic series or equivalent, unless otherwise indicated on Drawings.
2. Provide associated fittings as required.
3. Standard color as selected by the Architect.

H. Wireway

1. NRTL 870 listing throughout, including connectors and fittings.
2. Hinged cover construction.
3. Sealing capability where required.
4. Suitable for "lay-in" installation of conductors.
5. Rust inhibiting phosphatizing undercoat and baked enamel finish.
6. Plated hardware.
7. Square D "Square Duct" or equivalent.

I. Expansion Fittings

1. Metallic: OZ, Thomas and Betts Company, or equivalent.
2. Non-Metallic: Carlon, or equivalent.

J. Firestop Assemblies

1. Firestop systems shall consist of fittings and/or intumescent materials assembled as per UL (or other NRTL) System Details.
2. Product manufacturers: 3M, Chase Technology Corporation, Dow Corning Fire Stop, Hilti, International Protective Coatings Corp. (Flame Safe), Nelson Fire Stop Systems.

K. Thru Wall and Floor Seals

1. OZ-Gedney Type "FSK" or equivalent.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General

1. Electrically continuous throughout.
2. Plumb and level.
3. Cut square and reamed smooth.
4. Use commercial bender for offsets and bends.
5. Cap to prevent debris from entering during construction.

6. Swab conduit prior to installation of conductor.
7. Provide pull cord in empty conduits.
8. Alter conduit routing to avoid structural obstructions, minimizing crossovers.
9. It is the intent of this Specification to provide reasonable provisions for future expansion of electrical use (See NEC 90.8 and 90.1(B), FPN). Therefore, **install all branch circuit home runs as shown on Drawings. Do not combine home runs or increase quantity of conductors therein.**
10. Install raceway, conduit and fittings in accordance with Code, NRTL listing and manufacturer's recommendations.

B. Concealed Interior Raceway

1. Conceal all raceway within building construction.
2. May be run in a direct line for Contractor's convenience.
3. For Contractor's convenience, **concealed** stubs from concrete-encased PVC conduit runs may extend to first **concealed** junction box.
4. Where applicable, center within insulation any electrical conduit routed in attic space. Provide sealing as per NEC 300.7(A) for all conduits exposed to different temperatures.

C. Exposed Interior Raceway

1. Use limited to mechanical and electrical equipment rooms, motor connections, and panelboards scheduled as surface.
 - a. Run parallel or perpendicular to building lines.
 - b. **Provide RGSC or EMT stubs for concrete-encased PVC conduit runs.** Extend stub from RGSC coupling set flush in floor.
 - c. Provide flexible conduit as required for motor and equipment connections.
2. Shall not be used in finished areas unless specific permission is obtained from Engineer.
 - a. Exposed interior raceway in finished spaces shall be Metal Surface Raceway. Metallic conduit and tubing NOT ALLOWED.

D. Concrete Encased Raceway

1. Shall not interfere with structural integrity of slab, column, or beam.
2. Installation subject to acceptance of Structural Engineer.
3. Maximum diameter 1/3 thickness of concrete member.
4. Install in center of section.
5. Provide expansion fitting when crossing building expansion joint. Grounding integrity of raceway to be maintained.

E. Exterior Raceway

1. Minimum 24" below grade.
2. PVC unless otherwise indicated.
3. **Exterior surface stubs for PVC conduit runs: RGSC, including final underground sweep.** Exterior surface stubs acceptable only where specifically shown.
4. Penetrating Watertight Walls or Floors: Provide block-out with 1/2" clearance around conduit for underground penetrations. Pack with Oakum and caulk with non-shrinking grout, or provide conduit entrance seal.
5. Penetrating Roof or Waterproofing Membranes: Provide flashing and pitch pocket.

6. Contractor responsible for providing a watertight penetration.
7. Coat RGSC penetrations with heavy asphaltic-base compound.
8. Unless otherwise indicated, route exterior conduits to interior distribution equipment concealed under slab.

F. Supports

1. Refer to NEC 300.11
2. **Tie wire supports not acceptable.**
3. Support Spacing: NEC.

G. Specific Locations

1. Allow 6" minimum clearance at flues, steam pipes and heat sources.
2. Conduit visible behind grills and registers: paint black.
3. Seal conduit where leaving heated area and entering unheated area.
4. Penetrating non-watertight walls or floors: Pack space between conduit and block-out on both sides with Oakum.
5. Penetrating fire rated walls or floors: Seal to prevent passage of fire or products of combustion.
6. From each flush mounted panel location, stub three additional 3/4" conduits into nearest accessible ceiling space.
7. Do not mount raceway on ductwork, cover access doors, panels, controls, or otherwise hinder normal maintenance and repair of the equipment.
8. Motors:
 - a. Connect to motor feeder or branch circuit by means of flexible metal conduit or liquidtight flexible metal conduit in moist areas.
 - b. Minimum flexible length: 18".
 - c. Where practical, feed floor mounted motors from raceway installed in or under slab.
 - d. When floor mounted motors are fed overhead, provide required support for raceway. Extend raceway to floor and provide a floor flange. Insert "T" conduit fitting at proper height and extend flexible conduit to motor.

3.2 SIZE

A. National Electrical Code, subject to stated minimums.

B. Minimum Size

1. Exterior raceway: 3/4".
2. In or under poured concrete (including precast concrete panels): 3/4".
3. Branch circuit home run: 3/4". Consider home run to include raceway length from panelboard, switchboard, or motor control center to nearest power consuming or switching device on that circuit.
4. Feeders: 3/4".
5. All others not listed: 1/2".

3.3 TYPE

A. Intermediate Metal Conduit (IMC)

1. May be used in place of rigid galvanized steel conduit for Contractor's convenience.
2. Comply with manufacturer's recommendations for bending, threading and cutting operations.
3. Install as specified for rigid galvanized steel conduit.

B. Rigid Galvanized Steel Conduit (RGSC)

1. Use:
 - a. Overhead electric and telephone service entrance. IMC or Aluminum not acceptable for this application.
 - b. All raceway exposed to weather. Aluminum not acceptable for this application.
 - c. Where required by national, state and local codes.
2. Fittings: Threaded except at KO type boxes where double locknut/bushing method acceptable.
3. Waterproof entire length with heavy asphaltic base compound when:
 - a. Embedded directly in earth.
 - b. Embedded in concrete directly in contact with earth, with or without vapor barrier.
 - c. Penetrations run directly from concrete with earth, to soil burial.
4. Factory applied PVC coating acceptable in place of asphaltic base compound.

C. Rigid Non-Metallic Conduit (PVC)

1. Use only in slabs and exterior underground locations. See 3.1 B3, C4 and E3 for limitations.
2. Provide insulating bushing at all terminal adapters.
3. Provide equipment grounding conductor within raceway.
4. Increase trade size accordingly for equipment grounding conductor.
5. Utilize commercial heating element type bending equipment. **Do not use torches to bend PVC conduit.**

D. Electrical Metallic Tubing (EMT)

1. Use in all areas not prohibited by NEC and this Specification.
2. Do not use in concrete slabs on or under grade, or walls under grade.
3. Do not use in exterior underground applications.

E. Flexible Metal Conduit

1. Use for connections to transformers, motors, fixed appliances, recessed luminaires and other equipment as required.
2. Use liquidtight conduit with liquidtight fittings in areas of high moisture content.

F. Metal Surface Raceway

1. Install complete with matching boxes, fittings, and end caps, parallel or perpendicular to building construction.
2. Wire adjacent devices to alternate circuits where metal surface raceway contains devices integral to the channel.

3. Feed from flush connector in wall directly into raceway. Field cut base as required with 1/2" knockout for this purpose. Do not utilize Wiremold catalog #2051H for 2000/2100 series.

G. Fire Resistive Walls and Decks

1. Preserve integrity of fire rating through the use of UL (or other NRTL) Listed firestop assemblies of appropriate penetration type and rating time.
2. Install in accordance with manufacturer's recommendations.
3. All floor to floor penetrations and all wall penetrations into Mechanical, Electrical, and Communications Rooms shall be sealed with 1 hour firestop assemblies unless more stringent rating is required by building codes.
4. Include UL (or other NRTL) firestop assembly sheets and manufacturer product data sheets specifically used with the Project Closeout Documentation.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide all outlet, pull and junction boxes complete with associated covers and rings.

B. Work Installed But Furnished Under Other Directives.

1. Obtain manufacturer's backboxes or recommendations for special equipment.

1.2 SUBMITTALS

A. Record Drawings

1. Maintain accurate record drawings in accordance with Section 260500.

PART 2 – PRODUCTS

2.1 CEILING BOXES

A. Flush and Surface

1. 2-1/8" minimum depth.
2. Square or octagon as required.
3. Galvanized steel.
4. Manufacturer: Appleton, Raco, Steel City or equivalent.

2.2 WALL BOXES

A. Flush

1. One and two gang wall boxes: 4" square box, 2-1/8" minimum depth with appropriate plaster or tile ring.
2. More than three gang: Gangable 3-1/2" deep unless wall cavity limits depth to 2-1/2".
3. Use 4-11/16" square boxes where required by Code.
4. Single gang masonry boxes acceptable only for single conduit entrance. Feed-through circuiting not acceptable. Use 4" square box/tile ring for feed-through applications.

B. Surface Mounted Devices

1. 4" square box, 2-1/8" minimum depth with appropriate 1/2" raised cover.
2. Manufacturer: Appleton, B-Line, Raco, Steel City, Wiegmann, or equivalent.

C. Sectional, through wall and handy boxes not acceptable.

2.3 PULL AND JUNCTION BOXES

- A. Galvanized steel with cover.
- B. Size: National Electrical Code.
- C. Manufacturer: Appleton, Raco, Hoffman, Shallbetter, Steel City, Wadsworth or equivalent.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with code, product listing and manufacturer's recommendations.
2. Install boxes plumb, level and flush with finish surface.
3. Support securely and rigidly.
4. Verify wall depths to ensure adequate clearance for special backboxes.
5. Provide barriers in ganged switch outlets where voltage between adjacent switches exceeds 300 volts.

B. Location

1. Governed by structural conditions and obstructions.
2. Mount switch outlet on strike side of door, maximum 4" from door opening to first switch. Verify door swing with Architectural Plan.
3. Coordinate equipment outlets prior to installation for proper concealment.
4. Center outlets with respect to acoustical tile, paneling and furring trim.
5. Adjust outlets in masonry or tile construction to horizontal and vertical mortar joints.
6. Clear all piping, ductwork and other obstructions.
7. For outlet boxes on opposite sides of walls or partitions with separation distances of 24" or less, pack all interconnecting conduits with Duxseal after conductor installation, to prevent sound transmission.
8. Outlet boxes improperly located shall be corrected at Contractor's expense.

C. Mounting Heights

1. All device mounting heights shall conform to ADA Recommendations. Refer to Standard Electrical Symbol Legend for nominal mounting heights.
2. Verify height of all outlets to ensure installation above top of radiation covers, mirrors, counters and any other obstructions that may alter nominal mounting height.
3. **Measure from finish floor to centerline of outlet.**
4. Mount exterior outlets horizontally. Measure height from nearest interior finish floor below outlet.
5. Mount outlet designated AC (above counter) no less than 4" higher than top of countertop backsplash.

D. Fire Resistive Walls and Ceilings

1. Penetrations for steel electrical outlet boxes permitted, provided:
 - a. Boxes do not exceed 16 square inches in area.
 - b. Area of such openings shall not exceed 100 square inches for any 100 square feet of area.
 - c. Outlet boxes on opposite sides of walls or partitions separated by horizontal distance of 24 inches.

E. Pull and Junction Boxes

1. Pull and junction boxes are generally not indicated on Drawings.
2. Install in accordance with National Electrical Code and as required to facilitate wire pulling.
3. Do not install in finished spaces without approval of Engineer.

F. Identification

1. Identify pull and junction boxes containing system voltages in excess of 250 volts to ground with voltage markers.
2. Voltage markers: Not visible in finished areas.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Label electrical equipment as required by Codes and Specifications and as specifically directed by Engineer.

PART 2 – PRODUCTS

2.1 PANEL DIRECTORIES

- #### **A. Include directory cards with panelboards.**

2.2 NAMEPLATES

- #### **A. Machine engraved black laminate with white core, except as otherwise indicated.**
- #### **B. Minimum letter size: 1/8".**
- #### **C. Minimum plate size: 1" X 3".**

2.3 VOLTAGE MARKERS

- #### **A. Vinyl impregnated cloth markers with legend as required.**
- #### **B. Manufacturer: Ideal #44-360, or equivalent.**

2.4 PRESSURE SENSITIVE TAPE

- #### **A. Use only when specifically referred to in other Sections.**
- #### **B. Manufacturer: Dymo, or equivalent.**

2.5 UNGROUNDED CONDUCTOR IDENTIFICATION

- #### **A. As per NEC 210.5(C) and 215.12(C).**
- #### **B. Typewritten cards behind plastic shield, affixed with double-stick carpet tape. Heat surface prior to affixing directory.**

PART 3 – EXECUTION

3.1 GENERAL

A. Directory Cards

1. **Typewritten only.** Hand lettering unacceptable, except at "spares" and "spaces", where neat hand lettering with erasable pencil is required.

2. Indicate type of load and rooms where load occurs.
3. **Do not use room numbers as shown on Drawings, but refer to name and numbers on door.**
4. Do not identify until final load balancing is accomplished.

B. Nameplates

1. Apply plumb and level with two counter-sunk screws.
2. Glue, double-stick tape, or similar adhesive not acceptable.

C. Device Plates

1. Machine engrave directly on plate in lieu of separate nameplate.
2. Fill inscriptions with contrasting color.

D. Voltage Markers

1. Not visible in finished areas.

E. Junction Boxes

1. Mark all covers with indelible marker to indicate panelboard designation and circuit numbers for circuits contained within box.

3.2 EMERGENCY SYSTEM COMPONENTS

- A. All boxes and enclosures (including transfer switches, generators and power panels) for emergency circuits shall be permanently marked so they will be identified as a component of an emergency circuit for system.

3.3 SERVICE EQUIPMENT FAULT CURRENT NAMEPLATE

- A. Provide warning nameplate on each service disconnecting means enclosure indicating the fault current of the system.
- B. Fault current shall be calculated at the utility transformer, using an assumed infinite primary bus, and using the actual transformer impedance and kVa values.
- C. Red laminate with white core.
- D. Letter height: minimum 1/4"
- E. Legend

SERVICE AVAILABLE FAULT CURRENT: _____
TRANSFORMER KVA: _____
TRANSFORMER IMPEDANCE: _____
DATE: _____

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. The Contractor shall provide operational electrical connections to all electrically driven or controlled equipment.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General

1. The Contractor shall provide all necessary materials and labor required to make final operational connections to all equipment, generally as shown on the Drawings, and specifically as required by equipment specifications and installation literature.
2. Control devices and panels furnished by others will be delivered to the contractor at the jobsite, and shall be installed in accordance with manufacturer's printed instructions. Review equipment specifications to determine extent of work involved.

PART 3 – EXECUTION

3.1 GENERAL

- A. Provide operational connections for all equipment shown on the Drawings. Connections shall be in accordance with manufacturer's recommendations, and shall be left operating in a manner acceptable to the Engineer and Owner.
- B. Provide available fault current calculations for equipment listed in Section 260500-1.4E based on actual installation criteria (conductor lengths, raceway types, etc.). Calculations shall incorporate the current limiting effects of fuses supplied with local disconnecting means. Include calculation information in Record Manuals.
- C. For all exterior mechanical equipment, provide weatherproof GFCI receptacle outlet within 25' of equipment, circuited to nearest unswitched power. Refer to NEC 210.63 and 406.8.
- D. For all mechanical equipment located in attic and crawl spaces, provide porcelain lamp holder with integral receptacle and lamp guard, circuited to nearest unswitched power via pilot handle toggle switch near access hatch. Engrave plate. Refer to NEC 210.70(C).

3.2 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide panelboards where indicated and scheduled.

1.2 SUBMITTALS

A. Shop Drawings:

1. Submit information in accordance with Section 260500. Show all details of:
 - a. Lugs.
 - b. Locations for grounding bar, neutral bar and directory.
 - c. Main bus amperage and arrangement.
 - d. Weight and physical dimensions of enclosures.
 - e. Cover and lock type.
 - f. Quantity of spaces.
 - g. Quantity, arrangement, amperage and short circuit withstand ratings in RMS amperes for all circuit breakers.
 - h. Any other pertinent data.
 - i. Applicable series rating for this particular riser/fault current combination.

B. Record Manuals

1. Submit information in accordance with Section 260500.
 - a. Include fault current available at buss. Fault current calculations shall be based on actual installation criteria (conductor lengths, raceway types, etc.)
2. Include installation and maintenance instructions accompanying equipment.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Product of same manufacturer.
- B. Sizing and design based upon Eaton equipment; Eaton catalog numbers utilized for reference.
- C. Other Acceptable Manufacturers.
 1. Approved equal units by Siemens or Square D.
- D. Contractor is cautioned to verify all physical dimensions of "equal" units prior to accepting quotation for bid.

2.2 GENERAL

- A. Provide sub-feed lugs, contactors, main breakers or other equipment as scheduled.
- B. Provide copper bus, copper isolated neutral bar and copper grounding bar in all panelboards.
- C. Use load centers only where specifically indicated. Provide copper bus with plated aluminum neutral and grounding bar.
- D. NRTL-listed, and "suitable for use as service equipment" when required.
- E. Feeder risers are schematic only and not intended to infer lug arrangements. Contractor to indicate desired lug arrangements and sizes on shop drawings.
- F. Connection from load side of main breaker to panel bus shall be bus bar. Insulated wire and backfed types not acceptable.
- G. NRTL-recognized series ratings acceptable, with minimum ratings as specified herein.

2.3 BRANCH CIRCUIT PANELBOARDS

A. Circuit Breakers

- 1. Bolt-on.
- 2. Breaker Types:
 - a. Under 400 ampere: Quick-make, quick-break, thermal magnetic unless otherwise indicated.
- 3. Trip indicating.
- 4. Common trip on multi-pole breakers; handle ties not acceptable.
- 5. Minimum SCCR rating:
 - a. NRTL tested and certified series combinations acceptable.
 - 1) 10,000 for systems up to 240 volts.
- 6. Single pole 15 and 20 ampere ratings to be NRTL-listed as "Switching Breakers" and carry SWD marking.
- 7. FIRE ALARM EQUIPMENT
 - a. Circuit breakers feeding fire alarm control panels and/or other fire alarm equipment shall be equipped with a pad-locking device capable of locking the circuit breaker in the closed position.

B. Bus Assembly and Temperature Rise

- 1. Rating: As scheduled.
- 2. 98 percent conductivity.
- 3. "Distributed phase" or "Phase sequence" type bus bar connections.
- 4. Adjacent single pole breakers connected to opposite polarities.
- 5. Multi-pole breakers installable in any location.
- 6. Provisions for additional breakers such that field addition of connectors or mounting hardware will not be required.

C. Wiring Terminals

1. NRTL-listed as suitable for type of conductor specified.

D. Circuit Numbering

1. Starting at top, odd numbers in sequence down lefthand side and even numbers in sequence down righthand side.

E. Cabinet

1. Enclose bus assembly in steel cabinet.
2. Wiring gutter sizes and steel gauge in accordance with NEMA and NRTL standards.
3. Fabricate box from galvanized steel or equivalent rust resistant steel.
4. Furnish **without** pre-punched knockouts.

F. Fronts

1. Code gauge, full finished steel with rust inhibiting primer and baked enamel finish.
2. Not removable with door in locked position.
3. Adjustable trim clamps.
4. Concealed steel hinges.
5. Door with tumbler-type cylinder lock, catch and spring-loaded door pull.
6. Flush lock not to protrude beyond door front.
7. Key all locks alike.
8. Circuit directory frame and card with clear plastic covering on inside of door.

G. Manufacturer

1. Eaton Pow-R-Line series.

2.4 CABLE TIES

- A. Thomas and Betts Company "Ty-Rap" or equivalent.

2.5 PLYWOOD BACKING FOR SURFACE MOUNTED PANELBOARDS.

- A. 3/4" grade AD, fire-resistant, painted gray (including edges).

B.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store panelboards in a cool, dry area prior to installation.

3.2 INSTALLATION

A. General

1. Install where shown on Drawings, plumb and level.
2. Top of trim 6'-3" above finished floor for wall-mounted panelboard.
3. Adjust operating mechanism for free mechanical movement.
4. Conductors neatly dressed and banded with nylon cable ties after final load balancing.
5. From each flush installation, stub three additional 3/4" conduits into nearest accessible ceiling space to provide for future utilization of spare circuits.
6. Provide 3/4" plywood backing for all surface-mounted panelboards.
7. Tighten all lugs in accordance with manufacturer's recommendations.
8. For all fusible distribution panelboards, arrange devices in descending order such that busbar space is at top and largest devices are at bottom.
9. Provide individual terminal or lug for each wire. Multiple wires to common terminal, or several terminals for single stranded conductor not acceptable.

B. Identification

1. Identify panelboards and directories in accordance with Section 260553.
2. Provide nameplate similar to following example:

PANEL L6
120/208 VOLT 3Ø 4W
2" C – 4 #3/0
FED FROM SWBD #1

3. When required, provide identification as per NEC 210.5(C) at each branch circuit panelboard.

3.3 TESTS

A. Balancing Load

1. Circuiting shown on Drawings is designed to produce equal loading on all phases.
2. Under actual operating, check and make circuit adjustments as required to produce balanced condition.

3.4 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide electrical service from MDU's point of connection to main switch.

B. Description of System

1. 120/208 V, 3 Phase, 4 Wire

PART 2 – PRODUCTS

2.1 METERING

A. Feed through metering

B. Utility company to furnish all instrument transformers and meters.

C. Meter Sockets: Provide as required by utility company.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Verify with utility company prior to Bid all specific equipment requirements, installation requirements and fees particular to this service installation and make allowances thereto.

B. Include in Bid all utility company fees and charges associated with service installation.

C. Include in Bid all miscellaneous lugs, ground rods, site and pad conduits, sleeves, and other appurtenances required for service installation and not provided by utility company.

D. Transformer and Equipment Pads

1. Concrete pads provided by Division 26.
2. Size per utility company requirements.
3. Coordinate installation.

E. Contractor totally responsible for all utility company coordination, metering equipment placement, and transformer location, with respect to service installation.

F. Service installation shall comply with "Electric Service Rules and Regulations" as published by Montana Dakota Utilities Company.

3.2 IDENTIFICATION

- A. Identify cabinets with nameplates in accordance with Section 260553.
- B. Inscription as directed by Engineer.
- C. Provide available fault current calculations for cabinets based on actual installation criteria (conductor lengths, raceway types, etc.). Include calculation information in Record Manuals.

3.3 CLEAN UP

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide wiring devices complete with device plates of matching or specified color. Wiring devices include receptacles for the connection of portable equipment and switches used for the control of both lighting and fractional horsepower motor loads. Also included are dimmers, occupancy sensors, photoelectric switches and time switches.

B. Work Installed But Furnished by Others

1. Where indicated, install devices furnished by other Divisions of this Specification.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying the equipment.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Device color: Gray or as selected by Architect. Verify with Architect. (Exception: Red devices on emergency circuits where applicable).
- B. All devices shall be of the same manufacturer, except where specifically noted otherwise with the phrase "NO SUBSTITUTION".

2.2 SWITCHES

A. AC Toggle and Keyed Switches

1. 20-ampere 120/277 volt AC and HP rated.
2. Industrial Grade.
3. Color coded face or body by amperage.
4. Screw pressure plate back wire and side wire.
5. Federal Spec WS-896 listed.
6. Acceptable Manufacturers:
 - a. Cooper 2220 series
 - b. Hubbell 1220 series
 - c. Leviton 1220 series

d. Pass & Seymour

PS20AC series

B. Pilot Light Switches

1. Neon lamp in red toggle handle, lit in "on" position.
2. 20 ampere, 120/277 volt AC rated.
3. Manufacturer: As listed above.

C. Time Switches

1. Two Circuit SPST switching, voltage rating as required.
2. Digital display with 7-Day programming.
3. Non-volatile program memory (battery backup unacceptable).
4. Manufacturer: Intermatic #ET2725 series.
5. Other acceptable manufacturer: Tork.
6. Special units as shown on Drawings.

D. Remote Photoelectric Switches

1. Threaded swivel mounting with locking nut and neoprene gasket.
2. Light level adjustment slide.
3. Activation: 1-5 footcandle on, 3-15 footcandle off.
4. Manufacturer: Intermatic #K4200 series, wattage and voltage as required.
5. Other acceptable manufacturers: Paragon, Area Lighting Research, Precision, or Tork.

E. Spring Wound Timer Switch

1. As shown on Drawings.
2. Manufacturer: Intermatic.
3. Other acceptable manufacturers: Area Lighting Research, Rhodes Mark Time, or Tork.

F. Occupancy Sensors

1. Wall Mount
 - a. Self-contained line voltage unit with passive infrared sensing.
 - b. Rating: 120 VAC @ 800 watts, 240/277 VAC @ 1200 watts, electronic ballast rating. No minimum load requirements
 - c. PIR collector beams view out horizontally 35 feet in a wall-to-wall pattern, with a 20-foot effectiveness for small hand or body motions.
 - d. Adjustable time delay, from 5 to 20 minutes, with "OFF" override switch.
 - e. Automatic adjustment option for continuous time of day usage monitoring with automatic off delay adjustment.
 - f. Bypass mode to allow override button to act as a standard on-off switch in case of sensor failure.
 - g. Vandal resistant lens.
 - h. LED activity Indicator.
 - i. Multi-way version:
 - 1) Simultaneous load control from up to four device locations.
 - j. Dual-level version (ab switching):
 - 1) Two separate relays with dual override switches.

- 2) Independent Auto or Manual mode per relay.
- k. Manufacturer: WattStopper PW series, Sensorswitch WSX series, Leviton OSSMT series, Hubbell LHIR series, or approved equal.

2.3 RECEPTACLES

A. General Purpose

1. 20 ampere, self-grounding, NEMA 5-20R, industrial specification grade.
2. Nylon face with finder grooves and compact body.
3. Minimum 0.032" triple wipe brass contacts.
4. Corrosion resistant steel strap interlocked with face and body.
5. Screw pressure plate back wire and side wire.
6. Tamper resistant.
7. Federal Spec WC-596 listed.
8. Acceptable Manufacturers:
 - a. Arrow Hart TR5362xx
 - b. Hubbell HBL5362xxTR
 - c. Leviton 5362-SGxx
 - d. Pass & Seymour TR5362xx

B. GFCI

1. 20 ampere, feed-through type.
2. Two utilization points per device, with vertical orientation.
3. Tamper Resistant.
4. Manufacturer: As listed above.

C. Combination Duplex and USB Charging

1. 20 ampere, Decora style.
2. Two utilization points per device, with vertical orientation.
 - a. Includes one USB-A port.
 - b. Includes one USB-C port.
3. 5 ampere, 5 Volt USB output.
4. Tamper resistant.
5. Manufacturers:
 - a. Arrow Hart TRUSBAC20
 - b. Hubbell USB20ACPD
 - c. Leviton M58AC
 - d. Pass & Seymour TR20USBAC6.

D. Damp & Wet Locations

1. All 15 and 20 ampere, 125 and 250 volt non-locking receptacles shall be listed weather-resistant type as per NEC 406.9(A) and 406.9(B)(1).
2. Manufacturer: As listed above.

2.4 DEVICE PLATES

A. Flush Interior

1. Opening for device intended.
2. 430 or 302/304 stainless steel, or as selected by Architect.
3. Where plastic plates are selected by Architect, provide thermoplastic type.
4. Manufacturer: Cooper, Hubbell, Leviton and Pass & Seymour.

B. Surface Interior

1. 1/2" raised cover

C. Damp & Wet Locations

1. Damp locations:
 - a. Refer to NEC 406.9(A).
 - b. Die-cast aluminum construction with stainless steel springs.
 - c. Unless indicated otherwise on the Drawings, Manufacturer: Pass & Seymour #4500 series or equivalent.
2. Wet locations:
 - a. Refer to NEC 406.9(B).
 - b. Unless indicated otherwise on the Drawings, Manufacturer: Red Dot #CKMU (horizontal) or #CKMUV (vertical), or approved equal by Hubbell.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General

1. Install device and plates where shown on Drawings in accordance with Code, product listing and manufacturer's recommendations.
2. Refer to Section 260534-3.1C for mounting heights.
3. Plumb and level.
4. Tight to wall.
5. Thoroughly cover wall opening around device.
6. Replace all devices and plates that become discolored or burned during construction.
7. Provide blank plates for unused openings.
8. Connect wiring devices by means of single conductor tails. Multiple wire connections not acceptable.
9. Tighten unused connection screws.

B. Identification

1. Identify wall switches which control lighting or equipment not in sight.
2. Refer to Section 260553-3.1C.

C. Receptacles

1. Vertical mounting with grounding pole at bottom.
2. Provide GFCI receptacles at NEC 210.8 locations.

D. Photoelectric Switches

1. Install on roof, in center of structure where viewing from ground is minimal.
2. Verify exact location with Architect.
3. Penetrate roof with 3/4" RGSC, securely fastened to structure.
4. Provide flashing to maintain roof integrity.
5. Mount 18" above finished roof surface.
6. Make connections in weatherproof junction box.

E. Occupancy Sensors

1. Provide adequate supports to any structures, ceilings and grid system to safely attach sensors.
2. Mount external power packs (required only for low voltage sensors) within junction box in accessible ceiling space.
3. Verify operating parameters with Engineer.

3.2 TESTS

A. Proper operation of lighting switches, dimmers and occupancy sensors.

B. Duplex Receptacles

1. Proper connections.
2. Test all receptacles with NRTL listed receptacle circuit tester similar to Bryant #5266-PT, or Ideal #EZ Check.

3.3 INSTRUCTIONS

A. Instruct Owner's personnel in proper operation, setting, and maintenance of time switches, dimmers, occupancy sensors, and GFCI receptacles.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide all fuses as required.

B. Work Furnished But Not Installed

1. Provide spare fuses for all sizes and classes required.
2. Quantity: 10%, with a minimum of three each rating, including motor starter control transformer fusing.

1.2 SUBMITTALS

A. Record Drawings

1. Indicate actual class, type and size of fuse installed in each device.

B. Record Manuals

1. Submit information in accordance with Section 260500.

PART 2 – PRODUCTS

2.1 FUSES

A. 600 Amperes and Less Protecting Feeders or Combination Motor/Branch Circuit Loads.

1. UL-listed, Class RK-1.
2. Manufacturer: Bussmann LPN-RK/LPS-RK, Littelfuse LLN-RK/LLS-RK, or Brush LEN-R/LES-R.

B. Plug Fuses

1. Dual element, UL-listed Type S with adapter.
2. Use only as indicated on Drawings for fused toggle switches.

PART 3 – EXECUTION

3.1 STORAGE

- #### **A. Store fuses in a cool, dry space prior to installation.**

3.2 INSTALLATION

A. General

1. Install fuses in accordance with Code, product listing and manufacturer's recommendations.
2. Verify equipment fuse sized for load prior to installation.
3. All fuses shall be of same manufacturer.
4. Do not mix fuse classes in individual applications.
5. Fuses are not required for switchboard devices marked "Spare".

B. Identification

1. Indicate on inside cover with pressure sensitive tape the size, voltage and type of fuse furnished for each device.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide disconnects where shown on Drawings or required by Code.
2. Provide enclosed circuit breaker where shown on the Drawings.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Indicate on submittal exact motor or equipment served.
3. Show all details including electrical ratings, enclosure dimensions and other pertinent data.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying the equipment.

PART 2 – PRODUCTS

2.1 DISCONNECT SWITCHES

A. Switch Interior

1. Positive “off” position.
2. Lugs: NRTL-listed for aluminum and copper cable.
3. Plated current carrying parts.

B. Switch Mechanism

1. Quick-make, quick-break operating handle and mechanism.
2. Integral part of box.
3. Enclosures: Code gauge sheet steel (NEMA 1) or Code gauge galvanized steel (NEMA 3R).
4. Treat with rust-inhibiting phosphate primer.
5. Finish: Baked enamel.

C. Ratings

1. 240 or 600 volt.
2. Heavy duty.
3. Horsepower rated.
4. NRTL-listed "Suitable for Use as Service Equipment" when required.

D. Fusing

1. NRTL-listed rejection feature.
2. Reject all fuses except UL-listed Class R.

E. Manufacturer: Panelboard manufacturer.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Breaker Types:

1. Under 400 ampere: Quick-make, quick-break, thermal magnetic unless otherwise indicated.
2. Trip indicating.
3. Minimum SCCR rating:
 - a. 10,000 for systems up to 240 volts.

B. Manufacturer: Panelboard manufacturer.

2.3 PLYWOOD BACKING FOR SURFACE MOUNTED SWITCHES

- A. For interior locations, mount on 3/4" AD, fire-resistant, painted gray (including edges).

PART 3 – EXECUTION

3.1 STORAGE

- A. Store disconnect switches or enclosed circuit breakers in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install all required disconnect switches or enclosed circuit breakers in accordance with Code, product listing and manufacturer's recommendations.
2. Plumb and level.
3. Tighten lugs in accordance with manufacturer's recommendations.

B. Identification

1. Identify disconnect switches or enclosed circuit breakers in accordance with Section 260553.
2. Nameplate required for all disconnect switches. Nameplate to include load served, voltage, horsepower or MCA rating, and fuse size. Nameplate to be installed inside of cover on exterior disconnect switches.

Example:

RT-1
480 Volt, 3 Ø
35 MCA, 40 A Fuses

3. Do not use schedule number, but indicate load served.
4. Pressure sensitive tape identification for disconnect switches containing fuses.
5. Voltage markers on all disconnect switches containing system voltages in excess of 250 volts to ground.

3.3 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide integral Surge Protective Device in panelboards and switchboards where indicated and scheduled.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying equipment.

PART 2 – PRODUCTS

2.1 TYPE 2 SURGE PROTECTIVE DEVICE (SPD)

A. Provided only in panelboards and switchboards as indicated on the drawings.

B. The panelboard/switchboard manufacturer shall internally install SPD protection within the panelboard and the entire assembly shall be UL 67 listed.

C. SPD requirements:

1. Listed and component recognized in accordance with latest editions of UL 1449, UL 96A and UL 1283.
2. Minimum surge capacity ratings as indicated on the drawings. Operating voltage and configuration as indicated on the drawings
3. 200kA Short Circuit Current Rating (SCCR). SPD devices obtaining SCCR's using upstream over current protection are prohibited.
4. 20kA nominal discharge current.
5. EMI/RFI noise filtering attenuation up to 50dB for 10kHz – 100MHz.
6. Self contained module design, with each suppression element metal-oxide varistor (MOV) based incorporating thermal protection. End of life mode shall be open circuit.
7. Surge current diversion paths between each phase conductor and the neutral conductor, between each phase conductor and the ground and between the neutral conductor and ground. For delta configured systems, the SPD shall have components connected between each phase conductor and between each phase conductor and ground.

8. UL 1449 latest edition listed and recognized component voltage protection rating (VPR) shall not exceed:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>	<u>L-L</u>
240/120 1Ø	700V	700V	700V	1200V
208Y/120	700V	700V	700V	1200V
240D/120	700/1200V	700/1200V	700V	1800V
480Y/277	1200V	1200V	1200V	2000V

9. Designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
10. Equipped with on board visual and audible diagnostic monitoring devices mounted on the front cover of the SPD.
- Indicating lights shall provide full time visual diagnostic monitoring of the operational status of each phase of the surge current diversion module.
 - Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm.
 - LCD display surge counter located on the front cover of the SPD. Counter shall be equipped with a manual reset with protection from accidental operation and utilize non-volatile memory.
 - A set of Form "C" dry contacts shall be provided for remote annunciation.
11. Warranty: The panelboard manufacturer shall warranty the SPD for full replacement if destroyed by transients, including lightning, for a period of ten (10) years.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. SPD protection modules shall be factory installed by the panelboard/switchboard manufacturer integral to the panelboards/switchboards indicated on the drawings. Each entire assembly shall be UL 67 listed.

3.2 TESTS

- A. Verify all SPD equipment is active and in proper working condition prior to final project inspection.

3.3 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Furnish and install a complete luminaire for each lighting outlet.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500 including voltage, housing and door frame material, lens type, diffuser thickness, lumen output, and color temperature.

B. Record Manuals

1. Provide information in accordance with Section 260500.

1.3 COORDINATION

- A. Confirm compatibility and interface of luminaire with other materials and job conditions prior to ordering. Report discrepancies to Engineer and defer ordering until clarified.
- B. Provide frames, trim rings, and backboxes as required.
- C. Coordinate with work of all other Divisions to avoid conflicts between luminaires, supports, fittings and mechanical equipment. Ceiling clearances are minimal. It is imperative that Contractors coordinate conduit and duct runs to facilitate luminaire installation as shown on reflected ceiling plans. Engineer will not be responsible for interferences arising from lack of field coordination between trades.

PART 2 – PRODUCTS

2.1 LUMINAIRES

A. General

1. UL or other NRTL listed.
2. Where shown to be installed in fire-rated assemblies, luminaires shall be listed in accordance with UL Standard 1598. Supplemental penetration protection (tenting) will be accomplished by General Contractor in accordance with UL Fire Resistance Directory. Coordinate installation with General Contractor. Supplemental protection shall be spaced minimum 1/2" away from the luminaire, per UL Standard 1598.
3. Verify ceiling finishes and equip all recessed luminaires with appropriate frames as required.
4. Furnish luminaires intended for use in lay-in grid ceilings with proper clips for compliance with NEC.
5. Refer to Section 260500 for "Prior Approval to Quote" procedure.

B. LED Lighting Systems

1. General: All LED lighting system components must be UL or other NRTL listed.
2. Light Engines:
 - a. Meets or exceeds 70% lumen maintenance at 50,000 hours based on IESNA LM-79-2008.
 - b. Minimum 80+ CRI rating.
 - c. 4000K color temperature, or as scheduled on drawings.
 - d. Minimum delivered lumens as scheduled on drawings.
3. Electronic drivers for LED's:
 - a. Factory installed.
 - b. Multi-volt for use on either 120v or 277v systems.
 - c. THD: < 20%.
 - d. Factory installed quick-disconnect plug internal to the luminaire for driver removal.
 - e. Rated for a minimum of 50,000 hours.
 - f. 0-10 Volt dimming standard. Provide non-dimming drivers only as scheduled.
 - 1) Controls and wiring as per manufacturer's recommendations. Provide power packs for wall-box dimmers as required for positive luminaire off.
4. Downlights shall incorporate integral diffuser type lens. Exposed modules not acceptable.
5. Emergency battery packs:
 - a. Include self-testing/self-diagnostics with audible alarm option.
 - b. Factory installed.
 - c. Minimum lumens as scheduled.
6. Spare Drivers:
 - a. Luminaire manufacturer shall keep reasonable driver stocks on hand for replacement of defective drivers under guarantee period.
7. Guarantee period: Minimum 60 months from date of substantial project completion.
 - a. Guarantee shall include all parts and labor required to bring luminaire to complete operation.
 - b. Labor shall be performed by an Owner approved Electrical Contractor licensed in the area the work is to be performed.
 - c. Any costs for equipment rentals required to service luminaires under warranty shall be the responsibility of luminaire manufacturer.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store luminaires in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install luminaires plumb and true, free of light leaks, warps, dents and other irregularities.
2. Equip any outlets not specifically labeled with a luminaire the same as those in rooms used for similar purposes.
3. Run all directional lenses the same direction in rooms, corridors and other adjacent areas that contain square luminaires.

4. Continuous row luminaires: Hang level in straight line and butt tightly together.
5. Verify exact location of luminaires with reflected ceiling plan. Any discrepancies between the lighting plan, reflected ceiling plan, or installed ceilings shall be brought to the attention of the Engineer for clarification prior to installation.
6. Coordinate with Mechanical Contractor in advance of installation to prevent space conflicts.
7. Connect recessed luminaires to branch circuitry by means of single flexible metal conduit 6'-0" in length.

B. Barriers

1. Required where recessed luminaires are installed in insulated ceilings.
2. Suitable material to satisfy NRTL requirements.
3. Provided by Division 26 when not indicated otherwise.
4. Coordinate installation.

C. Luminaire Supports

1. Provide adequate supports to any structures, ceilings and grid systems to safely suspend or attach luminaires.
2. General Contractor to provide ceiling support systems as required by that portion of the Specifications. Electrical Contractor to provide any additional supports on an "as needed" basis to prevent ceiling from sagging or developing other irregularities.
3. Contractor responsible for providing proper suspension and mounting devices and to safely support all luminaires shown on Drawings, regardless of ceiling systems.
4. Rigidly support surface suspended ceiling system with anchors, hangers or clips designed for the purpose.
5. Support surface-mounted luminaires at four-foot intervals.
6. Install recessed luminaires in accordance with manufacturer's recommendations.
7. Rigidly support recessed luminaires to structural members or properly supported ceiling system with hangers, clips or fasteners designed for the purpose.
8. Support pendant and stem-hung luminaires at four-foot intervals.

D. 0 – 10 Volt Dimming Control Circuits

1. Installed in accordance with NEC Article 725.
2. Class 1 systems
 - a. #14 AWG THWN/THHN solid conductors installed in the same raceway as associated power wiring.
3. Class 2 systems
 - a. #18/2 non-shielded cable unless otherwise indicated on the drawings.
 - b. Plenum rated where required.
 - c. Cable shall be installed in raceway when concealed within walls, in mechanical rooms, and rooms without ceilings.
 - 1) DO NOT INSTALL IN SAME RACEWAY AS POWER CIRCUITRY.
 - d. Cable not required to be enclosed in raceway when installed above accessible ceilings.
 - 1) Route cables parallel or perpendicular to building construction.
 - 2) Support cables from building structure utilizing approved methods.
 - 3) Neatly coil excess cable length of pre-terminated assemblies.

- 4) All cable runs shall be continuous between devices. NO SPLICING.

3.3 TESTS

- A. Upon completion of this portion of the Work and prior to its acceptance by Owner, check for proper alignment and operation of all lighting equipment.

3.4 CLEAN UP

- A. Clean all luminaires immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide all wiring and control equipment not furnished with overhead door, for complete and satisfactory operation.

B. Overhead door wiring includes:

1. Power connections.
2. Control station installation.
3. Control connections between limit switches, safety devices, and door operator.

C. Work Not Included

1. Refer to overhead door section of specification for extent of material furnished with door.

PART 2 – PRODUCTS

2.1 MATERIAL

A. Disconnect Switches

1. Refer to Section 262816.
2. Separate switches required for each door.
3. Toggle switches acceptable for 115 volt rated motors.

B. Outlet Boxes

1. Refer to Section 260534.

PART 3 – EXECUTION

3.1 INSTALLATION

- #### **A.**
- Install controller, push-button or key-operated stations for each overhead door. Provide conduit, boxes and wiring material required for electrical connection, including control cable connection to limit switches and safety devices.

- #### **B.**
- Where used, locate key-operated control stations on exterior of building, flush mounted. Seal conduit after conductor installation.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Furnish and install all electric heating equipment as scheduled on Drawings.

1.2 SUBMITTALS

A. Shop Drawings

1. Provide information in accordance with Section 260500.

B. Record Manuals

1. Provide information in accordance with Section 260500.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Size, wattage and control as scheduled.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store electric heating equipment in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. Install in accordance with Code, product listing, and manufacturer's recommendations.
- B. Mount baseboard heaters above Architectural base.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The provisions and requirements of Section 260500 shall be applicable to Division 27.
- B. All Division 27 work shall be included under the Division 26 contract.
- C. The Contractor shall take special note that any conflicts between the Contractor and any Division 27 subcontractors shall not become an issue of the Engineer or Owner. It shall be the Contractor's responsibility to coordinate with the Division 27 subcontractor/s to determine where their work leaves off and where the subcontractor's work begins. The Contractor shall be responsible for all specified work including the operations of work under Division 27.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide raceways for network systems as shown on the Drawings.

B. Work furnished and installed by others.

1. Local serving telephone utility shall place the service entrance cable to the point of presence, install circuit protection cabinet, protectors, and ground the entrance cable as needed to the service grounding conductor provided under this contract.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Main telephone terminal boards (TTB): ¾" grade AD fire-resistant plywood, painted gray (including edges). Dimensions as required by serving utility company.

B. Voice/data terminal board (TTB):

1. ¾" grade AD fire-resistant plywood, painted gray (including edges). Dimension as required by Owner's network system supplier. May be included with main telephone terminal board for single board installation.

C. Raceways:

1. As specified in Section 260533 and sized as shown on Drawings, minimum 3/4".

D. Boxes:

1. 2-1/8" deep unless restricted by wall thickness.
2. As specified in Section 260534 and 260540.

E. Blank plates:

1. As specified in Section 262726, yoke-mounted. Box-mounted plates not acceptable.

F. Firestop Assemblies

1. NRTL listed 4" square pathway with intumescent material designed to seal out fire, smoke, and toxic gases.
2. Quantity shall equal or exceed the width of the associated cable tray. i.e. a 6" wide tray requires two pathways.
3. Include mounting accessories as required by application specifics.
4. Manufacturer: EZ Path Series 44, 3M Model PT4SD or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Serving Communications Utility Requirements

1. Raceways:
 - a. Provide telephone service entrance conduit, stubbed to terminal board from property line.
 - b. Verify service entrance conduit size and quantity, and property line location with serving utility.
 - c. Provide bushing or connector at each conduit stub.
 - d. Provide pull wire in each telephone conduit run.
2. Provide surface double-duplex receptacle at main telephone terminal board, fed from dedicated spare circuit breaker. Receptacles to be isolated ground type, with separate grounding conductor connected to panelboard grounding bar.
3. Provide telephone board communication grounding bus as required by serving utility, minimum #6 solid SDBC in conduit, extended shortest and most direct route to ground bar at main switch. Terminate in ground bar affixed to telephone terminal board, location as directed by serving utility.
4. Entire installation to comply with serving utility company requirements.

B. Raceways:

1. Stub from rough-in location into nearest accessible ceiling space, or location as indicated on Drawings.
2. Provide bushing or connector at each conduit stub.
3. Provide pull wire in each voice/data raceway.
4. Provide raceway system where concealed in walls, in mechanical rooms and rooms without accessible ceilings.

C. Provide blank plates for all rough-in boxes not concealed by Owner's voice/data equipment.

D. Entire installation to comply with Owner's network systems supplier requirements.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide Network Cabling System as shown and described.

B. Work furnished and installed by others.

1. Voice: The Owner will provide all telephone handsets.
2. Data: The Owner will provide all end-user software, programming, computer servers, terminals and personal computers.
3. Surveillance: The surveillance system cameras, servers, switches and storage equipment will be provided and installed either by the Owner or under other Sections of this specification.

C. Description of System

1. Voice: Work shall include, but not be limited to, devices, faceplates, cables and cable assemblies, connecting blocks, cable management, terminations, and final acceptance testing.
2. Data: Work shall include, but not be limited to, devices, faceplates, cables and cable assemblies, cable management, patch panels, data racks, terminations, and testing.
3. Surveillance: Work shall include, but not be limited to, devices, cables and cable assemblies, cable management, patch panels, data racks, terminations, and testing.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Connection diagrams.
 - c. Description of devices.
 - d. Name of installation Contractor/Subcontractor.

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include manufacturer's data for adjustment, operation and maintenance of equipment and name of service organization.

PART 2 – PRODUCTS

2.1 MANUFACTURER/SUPPLIER

- A. The system specified is based on equipment as manufactured by General Cable, Panduit, Commscope and other manufacturers as listed. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met. Backboards, conduit, cable tray, and rough-ins shall be by Electrical Contractor.
- B. Contractors/Subcontractors performing Section 271500 work shall have personnel trained/certified in communications cabling installation via equipment manufacturers' or industry standards' training programs. Refer to Section 260500-1.5 Quality Assurance.
- C. Acceptable installers:
 - 1. Computer Store, 1100 S Broadway, Minot, ND 58701, 701/838-3967.
 - 2. Data Connections, 4016 37th Avenue NW, Mandan, ND 701/426-8771.
 - 3. Dell-Comm, Inc. 812 S 18th St., Bismarck, ND 58504, 701/222-2887.
 - 4. ECSI, 1711 12th Ave SW, Minot, ND 58701, 701/838-8401
 - 5. Gefroh Electric, 100 45th Ave NW, Minot, ND 58703, 701/838-0225.
 - 6. Innova Integrated Systems, 1800 22nd Ave SW, Minot, ND, 701/837-0131.
 - 7. Main Electric, 2626 Valley St., Minot, ND 58701, 701/852-3315.
 - 8. Muth Technology, 600 E Benson Rd, Sioux Falls, SD 57104, 800/888-1597.
 - 9. RBB Electric, 1123 N 1st St., Grand Forks, ND 58208, 701/775-7404.
 - 10. Wheeler Construction, 1720 South Broadway, Minot, ND, 58701, 701/852-5584.
 - 11. Installers not listed above and wishing to quote shall refer to Specification 260500-1.4 for approval procedure. No consideration shall be given to any installer not pre-approved.

2.2 DEVICES AND FACEPLATES

- A. Data jacks: Single outlet RJ45, eight-pin/eight wire, modular construction, TIA/EIA-568.2-D Category 6 compliant, T568A and T568B identification, Panduit Mini-Com #CJ688TG, Commscope #MGS400 series, Leviton #61UJK series, or approved equal.
- B. Voice jacks: Same as data jacks.
- C. Voice wall-mount face plate/jack assembly: Stainless steel with Category 6 keystone jack, Panduit #KWP6, Commscope #630B8, Leviton #4108W1SP series, or approved equal.
- D. Faceplates
 - 1. Single gang with ID windows and two or four modular inserts as dictated by jack count shown on the drawings.
 - 2. 430 or 302/304 stainless steel, or as selected by Architect.
 - a. Panduit #CFPL2/4 series, Commscope #M12/14SP-L series, Leviton #43080-1L2/4 series, or approved equal.
 - 3. Where plastic plates are selected by Architect.

- a. Panduit #CFPE2/4 series, Commscope #M12/14L series, Leviton #42080-2/4 series, or approved equal.
- E. Provide blank modules as required. Panduit #CMB, Commscope #M81, Leviton #41084 series, or approved equal.
- F. Color: Devices as selected by Owner, faceplates as selected by Architect.
- G. Surveillance Cameras
 - 1. Jack assembly for cameras mounted to accessible ceilings shall utilize Panduit Model #CBXQ1IW-A enclosure mounted to building structure above the ceiling. Surveillance system provider shall be responsible for patchcord between camera and jack.
 - 2. Cameras mounted directly to rough-ins or surface boxes shall utilize cable terminated to RJ45 Plug, Panduit Model #FP6X88MTG field terminating type or approved equal. Provide minimum 12" extra cable length within rough-in or camera mounting equipment.

2.3 CABLES AND CABLE ASSEMBLIES

- A. Trunk riser cables:
 - 1. #24 AWG Category 3 solid copper, plenum rated (unless enclosed in conduit the entire length).
 - 2. 100 unshielded twisted pair, unless otherwise indicated on Drawings.
- B. Station cables (voice and data): Four unshielded, twisted pair, #23 gauge, Category 6 – 350 MHz, solid copper conductor, cable tray and plenum rated.
 - 1. General Cable #7131900, Commscope #2088B, Berk-Tek #10032094 or equivalent meeting the following characteristics at 250 MHz.
 - a. ACR: 10.5 dB min. @ 100m
 - b. PS-ACR: 8.5 dB min. @ 100m
 - c. ELFEXT: 24.5 dB min.
 - d. PS-ELFEXT: 21.5 dB min.
 - e. NEXT: 43 dB min.
 - f. PS-NEXT: 41 dB min.
 - g. ATTEN.: 32.8 dB max. @ 100m
 - h. LCL: 26 dB min.
 - i. Return Loss: 20 dB min.
- C. Extended Range cable: Four unshielded, twisted pair, #22 gauge, Category 6, solid copper conductor, cable tray and plenum rated.
 - 1. Limited power listed for up to 90 Watts (PoE Type 4)
 - 2. Certified for 10 Mbps transmission up to 250 meters.
 - 3. Certified for 1 Gbps transmission up to 200 meters.
 - 4. General Cable #8131800, Paige #258300336, or equivalent meeting the following characteristics at 250 MHz.
 - a. Insertion Loss: 30.6 dB/100m max.

- b. Return Loss : 17.3 dB/100m min.
 - c. NEXT: 38.3 dB/100m min.
 - d. PSNEXT: 36.3 dB/100m min.
- 5. Use only where indicated on the Drawings.
- D. Outside Plant cable: Four unshielded, twisted pair, #23 gauge, Category 6, solid copper conductor, gel filled water block for underground/wet applications and UV resistant insulation.
 - 1. General Cable #7136100, Commscope #1572A, Berk-Tek #10139885 or equivalent meeting the following characteristics at 250MHz.
 - a. Insertion Loss: 32.8 dB max.
 - b. Return Loss : 17.3 dB min.
 - c. NEXT: 38.3 dB min.
 - d. PSNEXT: 36.3 dB min.
- E. Outside Plant Extended Range cable: Four unshielded, twisted pair, #22 gauge, Category 6, solid copper conductor, gel filled water block, wet listed, and extended range.
 - 1. Limited power listed for up to 90 Watts (PoE Type 4)
 - 2. Certified for 10 Mbps transmission up to 250 meters.
 - 3. Certified for 1 Gbps transmission up to 200 meters.
 - 4. General Cable #8146100, Paige #258330804, or equivalent meeting the following characteristics at 250 MHz.
 - a. Insertion Loss: 30.6 dB/100m max.
 - b. Return Loss : 17.3. dB/100m min.
 - c. NEXT: 38.3 dB/100m min.
 - d. PSNEXT: 36.3 dB/100m min.

2.4 WIRELESS ACCESS POINT (WAP) CABLING

- A. Cabling for WAP's shall be Limited Power Listed CAT 6A.
 - 1. Data jacks: Single outlet RJ45, eight-pin/eight wire, modular construction, TIA/EIA-568.2-D Category 6A compliant, T568A and T568B identification, Panduit Mini-Com #CJ6X88TG, or approved equal.
 - 2. Above Ceiling Installation: Panduit #CBXQ2IW-A, or Approved Equal surface termination box attached to building structure.
 - 3. Station cables: Four unshielded, twisted pair, #23 gauge, Category 6A – 500 MHz, solid copper conductor, cable tray and plenum rated. UL Listed CMP-LP (0.7A).
 - a. General Cable #7151850 or Approved Equal meeting the following characteristics per 100 meters at 500 MHz.
 - 1) ACRF: 13.8 dB min.
 - 2) PSACRF: 10.8 dB min.
 - 3) PSAACRF: 32.0 dB min.
 - 4) NEXT: 33.8 dB min.
 - 5) PSNEXT: 31.8 dB min.
 - 6) PSANEXT: 60.0 dB min.

- 7) Return Loss: 15.2 dB min.

2.5 MISCELLANEOUS PRODUCTS

A. Punch-down and connecting blocks

1. Category 6 rated.
2. 110-style base with mounting legs, 96-pair (24 port) or 288-pair (72 port) as required by cable/conductor count. High density 144-pair (36 port) or 432-pair (108 port) bases also acceptable. Manufacturer: Panduit #GPBW series, Commscope 110AW2 series or approved equal.
3. 4-pair connecting blocks for station cables. Manufacturer: Panduit #GPCB4 series, Commscope 110C-4.
4. 5-pair connecting blocks for backbone cables. Manufacturer: Panduit #GPCB5 series, Commscope 110C-5.

B. Cable management:

1. 6" die-cast aluminum distribution rings: Allen Tel #GB13C or equivalent.
2. Plenum velcro cable ties: Panduit #HLSP series or equivalent.
3. Cable hooks with retainers: B-Line #BCH series or equivalent.

C. Patch Panels

1. Patch panels shall have modular jack-style termination connectors, be 24-port or 48-port in size, one or two standard EIA rack spaces in height. The panels shall have separate port and panel designation strips. Panduit #CP24BL or #CP48BL, Commscope #M2400-1U-GS, Leviton #49255-H24 or #49255-H48, or approved equal.
2. Quantity: As required by station cable count.

D. Data Rack (DTR)

1. 20" deep 14U compact fully secure wall mounted enclosure with vented bottom, EIA/TIA 19" assembly. Blackhawk Labs #MRQ351S14, or equivalent, quantity as shown on drawings. Include Blackhawk Labs #S10 Pro kit, or equivalent, with Fan Tray, Brush Plates, and additional Pan Head Screws.
2. Identification:
3. Panduit #LS8E or Pan-Mark labeling systems or equivalent. Hand lettering not acceptable.

E. Power Strip:

1. 19" rack-mounted surge suppression strip. Six (6) NEMA 5-20 duplex receptacles. UL1449 listed. Clamping level not to exceed 330 volts.
2. Manufacturer: Leviton #5500-192 or equivalent.
3. Quantity: One per data rack.

2.6 COLOR

- A. All cables shall match their associated jack color for type of system served unless otherwise indicated.
- B. Verify cable and jack color configuration with Engineer/Owner's Rep.
- C. Typical color configuration.
 - 1. Voice Jacks – Match Faceplate (Yellow cable)
 - 2. Data Jacks – Yellow
 - 3. WAP – Orange
 - 4. Cameras – Purple

PART 3 – EXECUTION

3.1 STORAGE

- A. Store system equipment in cool, dry space prior to installation.

3.2 GENERAL

- A. Securely install components where shown on Drawings.
- B. Contractor shall adjust and provide all other assistance required at final inspection to bring the system satisfactorily on-line.
- C. Install in accordance with NEC, EIA/TIA Standards, NRTL listing, and manufacturer's recommendations and instructions.
- D. All cables that extend underground shall be listed for use in wet locations. See Outside Plant cables in Part 2 for requirements.
- E. Cable:
 - 1. Install cables in raceways as required by Section 270528 and in cable tray (communications type) where cable tray is specified.
 - 2. Route open air cables (where not in raceway or cable tray) parallel or perpendicular to building construction supporting with specified products, maximum 4'-0" on center.
 - 3. Bundle multiple open air cable runs located in TTB/TB rooms together with velcro cable ties
 - 4. Identify ends of cables with room designations as directed by Owner.
 - 5. Bending radius shall be minimum 1".
 - 6. All cable runs shall be continuous, **NO SPLICING.**

3.3 VOICE

- A. Install punch-down blocks at TTB/TB. Arrange one set of punch/down blocks for backbone cable(s) and second set for station cables.

- B. Install backbone cable(s) from TTB to TB(s) as shown on the Drawings.
- C. Install voice station cables from punch-down blocks at TTB/TB to the voice outlet locations as shown on the Drawings, terminated and identified at both ends according to Owner's convention.
- D. Provide cross-connect conductors to interconnect corresponding connecting blocks.
- E. Identify all punch-down blocks and face plate jacks according to Owner's convention.

3.4 DATA

- A. Provide Data Rack(s) as shown and specified.
- B. Install patch panels and cable management system in Data Rack.
- C. Install data station cable from patch panel to data outlet locations as shown on the Drawings. Cable length not to exceed 295 feet.
- D. Terminate cables according to T568A or T568B wiring scheme as determined by Owner's system requirements.
- E. Extended range cable to only be used where indicated on the Drawings, or where approved by the Engineer. Use of this cable is not permitted as an alternative to change or alter network system distribution locations or quantities.
- F. Identify cable at both ends according to Owner's convention. Arrange patch panels and patch panel jacks as per Owner's convention. Identify all patch panels, patch panel jacks, and faceplate jacks according to Owner's convention.
 - 1. If no convention is available, room numbers shall be incorporated into the identification.
Ex: For room 120, use 120-1 for first cable, 120-2 for second cable, etc.

3.5 SURVEILLANCE

- A. Install separate dedicated patch panels in Data Rack for the camera cables.
- B. Install station cable from patch panel to camera locations as shown on the Drawings. Cable length not to exceed 295 feet. Verify exact camera location and mounting configuration with Surveillance System installer.
 - 1. Extended range cable to only be used where indicated on the Drawings or where approved by the Engineer.
- C. Terminate cables according to T568A or T568B wiring scheme as determined by Owner's system requirements.
- D. Identify cable at both ends according to Owner's convention. Arrange patch panels and patch panel jacks as per Owner's convention. Identify all patch panels, patch panel jacks, and faceplate jacks according to Owner's convention.

1. If no convention is available, camera numbers shall be incorporated into the identification. Ex: For camera 21, use C-21.

3.6 GROUNDING

- A. For each data rack, provide one #10 AWG solid copper conductor from data rack to nearest panelboard with equipment ground bus.
- B. Where multiple data racks are located in single room (more than 2), provide isolated communication grounding bus in room. Extend #6 solid SDBC in conduit, extended shortest and most direct route to ground bar at nearest panelboard with equipment ground bus. Extend one #10 AWG solid copper conductor from each data rack to communication grounding bus in room.

3.7 TESTING REQUIREMENTS

- A. All terminated voice and data cables shall be tested and certified for TIA/EIA-568.2-D. Category 6 standards. The test shall be performed on the permanent link configuration (from station jack to patch panel jack). These standards require the following when tested at 250 MHz:
 1. Return Loss shall be no less than 10.0dB.
 2. Insertion Loss (Attenuation) shall not exceed 31.1dB.
 3. Near End Cross Talk (NEXT) shall be no less than 35.3dB.
 4. Power Sum Near End Cross Talk (PSNEXT) shall be no less than 32.7dB.
 5. Attenuation to Crosstalk Ratio Far-end (ACRF) shall be no less than 16.2dB.
 6. Power Sum ACRF (PSACRF) shall be no less than 13.2dB.
 7. Propagation Delay shall be less than 490 nanoseconds.
 8. Propagation Delay Skew shall be less than 44 nanoseconds.
- B. All terminated WAP cables shall be tested and certified for TIA/EIA-568.2-D. Category 6A standards. The test shall be performed on the permanent link configuration (from station jack to patch panel jack). These standards require the following when tested at 500 MHz:
 1. Return Loss shall be no less than 8.0dB.
 2. Insertion Loss (Attenuation) shall not exceed 43.8dB.
 3. Near-end Cross Talk (NEXT) shall be no less than 26.7dB.
 4. Power Sum Near-end Cross Talk (PSNEXT) shall be no less than 23.8dB.
 5. Attenuation to Crosstalk Ratio Far-end (ACRF) shall be no less than 10.2dB.
 6. Power Sum ACRF (PSACRF) shall be no less than 7.2 dB.
 7. Propagation Delay shall be less than 490 nanoseconds.
 8. Propagation Delay Skew shall be less than 44 nanoseconds.
 9. Power Sum Alien Near-end Cross Talk (PSANEXT) shall be no less than 49.5 dB.
 10. Power Sum Alien Attenuation to Crosstalk Ratio Far-end (PSAACRF) shall be no less than 23.7 dB.
- C. Additional testing shall include line mapping and cable length before final acceptance by Owner.
 1. DC resistance shall be less than 3% or less than 150 milli-Ohms.

- D. All permanent link cable runs shall be documented with a hard copy print-out of the test results. Compile one copy of test results in a loose-leaf binder, similar to manual references in Section 260500, 1.04E. Submit at project completion with referenced Record Manual.
- E. Field tester to be Level III and conform to TIA/EIA 568.2-D Annex A & B requirements.

3.8 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Provide TV Signal Cabling System as shown on Drawings.

B. Work Furnished and Installed by Others

1. Building service entrance cable to the TV termination point not in contract.

C. Description of System

1. The system shall have the capability to distribute signals supplied by the local cable company. Each TV outlet will require a separate feed from the TV distribution point(s). The signal shall be distributed to the rooms in the following manner:
 - a. When in the normal state, all programs will be distributed to all the rooms simultaneously.
2. The system shall provide for expansion of the system of future inputs, up to eight (8) total.

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Indicate mounting details, connection diagrams and description of system functions.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include manufacturer's data for adjustment, operation and maintenance of equipment and name of service organization.
3. Provide multiple copies, one to remain in central cabinet, other copies for Record Manuals.

PART 2 – PRODUCTS

2.1 MANUFACTURER/SUPPLIER

- #### **A.**
- The system specified is based on equipment as manufactured by Blonder Tongue and other manufacturers as listed. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.

B. Acceptable Suppliers:

1. AVI Systems, 1930 East Century Avenue, Bismarck, ND (701) 258-6360.

2. Computer Store, 1100 S Broadway, Minot, ND 58701, (701) 838-3967.
3. Data Connections, 4016 37th Avenue NW, Mandan, ND (701) 426-8771.
4. Dell-Comm, Inc., 812 South 18th Street, Bismarck, ND (701) 222-2887.
5. Kohler Communications Inc., 1429 Main South, Dickinson, ND (701) 225-5554.
6. Tricorne Audio, 4023 State Street, Bismarck, ND (701) 258-6912.

2.2 SPLITTERS

- A. Radiation shielded with one input and outputs as required.
- B. Meet CATV and SMATV requirements for RF shielding.
- C. 5 MHz to 2.4 GHz frequency range.
- D. Connections to use F type shielded hex crimped connectors.
- E. All ports have power-pass.
- F. Manufacturer: Blonder Tongue DCL series or equivalent.

2.3 OUTLETS

- A. TV Jacks: F-type connector supplied with 75 ohm self-terminating F-type coupler for SUB/VHF/CATV/UHF. Manufacturer: Panduit Mini-Com #CMFSR Series.
- B. Faceplates: Single gang, vertical faceplate accepting modular jack(s). Manufacturer: Panduit #CFP Series plates. Color as selected by Architect.
- C. Where TV and voice/data outlets are shown ganged together on the Drawings, device plates furnished under Section 271500.

2.4 CABLE

- A. Cable
 1. RG-6
 - a. #18 AWG .040 copper.
 - b. 100% foil/60% aluminum braid/100% foil/40% aluminum braid.
 - c. Type RG-6 Quad Shield Coax.
 - d. Plenum-rated where installed above accessible ceilings and not in raceway.
 - e. Manufacturer: Belden #5339Q5 or #6339Q8 (plenum-rated), or equivalent.
 2. RG-11
 - a. #14 AWG copper solid copper.
 - b. 100% foil/60% aluminum braid/100% foil/40% aluminum braid.
 - c. Type RG-11 Quad Shield Coax.
 - d. Plenum-rated where installed above accessible ceilings and not in raceway.
 - e. Manufacturer: Belden #70084NH-series or equivalent.

B. Cable Management:

1. Six inch die-cast aluminum distribution rings: Manufacturer: Allen Tel #GB13C or equivalent.
2. Velcro cable-ties: Manufacturer: Panduit HLX series or equivalent.
3. Bridle rings: Manufacturer: B-Line BR series or equivalent.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store TV signal cabling components in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. Install in accordance with Code, product listing, and manufacturer's recommendations.
- B. Contractor shall adjust and provide all other assistance required at final inspection to bring the system satisfactorily on-line.
- C. Service Conduit
1. Provide CATV service entrance conduit, stubbed to telephone terminal board from property line.
 2. Verify service entrance conduit size, minimum 2", and property line location with serving utility.
 3. Provide bushing or connector at each conduit stub.
 4. Provide pull wire in each CATV conduit run.
- D. Cable
1. Route cables parallel or perpendicular to building construction.
 2. Support cables with bridle rings, maximum 6'-0" on center.
 3. Bundle multiple cable runs together with velcro cable ties, maximum 3'-0" on center.
 4. Identify ends of cables with room designations as directed by Owner.
 5. Minimum one inch bending radius.
 6. All cable runs shall be continuous, NO SPLICING.
- E. Conduit
1. Provide minimum 3/4" conduit, where cable is concealed within new walls, in mechanical rooms and rooms without ceilings.
 2. Cable not required to be enclosed in conduit where installed:
 - a. In existing walls.
 - b. Above existing plaster ceilings.
 - c. Above accessible ceilings.
- F. Provide F-type, shielded, hex-crimped connectors at all cable ends.
- G. Provide splitters where indicated.

- H. Outlets shall be properly shielded to eliminate any leakage of signal. Tap values shall be designed so that signal levels can be kept at no more than +5 dB on Channel 41 @ 300 MHz.
- I. Exercise particular care for installation of control rough-in boxes to ensure plumb and level placement.
- J. Entire installation to comply with Owner's cable requirements.

3.3 TESTS

- A. Prior to final inspection, verify that the system is installed in accordance with serving utility standards, and in proper working condition. Furnish letter of verification to Engineer indicating that the system has been tested by a manufacturer's representative. List date of test and name of manufacturer's representative.

3.4 INSTRUCTIONS

- A. Manufacturer's representative to instruct Owner in proper operation, maintenance and testing of the complete system. Include name of Owner's representative in letter of verification.

3.5 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION