

**SECTION 15044
PRESSURE TESTING OF PIPING**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, and equipment required for the pressure testing of all potablewater and all other equipment per these specifications.
- B. Related Work Described Elsewhere

1.02 STANDARDS

- A. The standards referenced in this section are as follows:
 - 1. Installation of Ductile-Iron Water Mains and Their Appurtenances AWWA C600-05 and AWWA C605-05

1.03 TEST PRESSURES

- A. Test pressures for the various services and types of piping are shown at the end of this section in Table 15044.

1.04 SUBMITTALS

- A. Test Report
 - 1. The Contractor shall submit a test report which includes the following information:
 - a. Date and time of tests.
 - b. Name(s) of person(s) conducting tests and company name.
 - c. Test locations.
 - d. All pressure gauge locations and pressures at time of tests.
 - e. Allowable leakage for test sections per Specifications.
 - f. Actual leakage during tests with the time and pressure at the end of the test.
 - 2. Submit five (5) copies and one (1) original copy of the test reports to the Engineer upon completion of the testing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Hydrostatic testing of all water and chemical solution lines shall be performed at 150 PSI for a period of not less than 2 hours. The test pressures of other piping systems are specified in Table 15044.
- B. Verification that the pipes have been cleaned and properly isolated shall be made.
- C. The maximum length of line to be tested as one section shall be 2,500 linear feet.
- D. The Contractor is responsible for providing all equipment required to perform the cleaning and testing of the piping and for performing the work.
- E. The pressure testing shall be in accordance with AWWA C600 and AWWA C605.

3.02 TESTING PREPARATION

- A. Pipes shall be in place and anchored before performing the pressure testing.
- B. Conduct hydrostatic and pneumatic tests on exposed and above ground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been poured. When testing mortar-lined piping, fill the pipe to be tested with water and allow it to stand full for at least 48 hours to absorb water before conducting the pressure test.
- D. Before conducting hydrostatic tests, the pipes must be cleaned. Mains 8" in diameter and larger shall be cleaned using a poly-pig. Mains smaller than 8" in diameter may be cleaned by the flushing required prior to disinfection of the piping, using potable water at a minimum velocity of 2.5 feet per second to remove the dirt and debris. For pneumatic tests, air shall be blown through the pipes prior to the testing. Prior to any flushing operations, the Contractor shall notify the Owner and the Engineer for coordination. Flushing and/or cleaning of mains smaller than 10" requires a minimum of 48 hours advance notice and flushing and/or cleaning of mains 10" and larger requires a minimum advance notice of 1 week. An Owner's representative and/or an Engineer's representative shall be present during all flushing and all flushing shall take place during off-peak demand periods.
- E. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind

flanges. After the new line has been successfully tested, remove caps or flanges and connect to the existing piping.

- F. Conduct hydrostatic tests on buried pipe after the trench has been completely backfilled. The pipe may be partially backfilled and the joints left exposed for inspection for an initial leakage test. Perform the final test, however, after completely backfilling and compacting the trench.

3.03 TESTING

A. Water and Chemical Solution Piping:

1. All air shall be purged while the piping is being filled. Once all of the air is removed, the piping system shall be subjected to the required test pressure for a preliminary test. All joints, fittings, valves, and connections shall be examined for leaks. Correct leaks prior to starting the actual test.
2. Once all visible leaks have been repaired, the test pressure (150 PSI) shall be applied and maintained for a period of 2 hours by means of a hydraulic pump taking supply from a container suitable for measuring water loss. The amount of loss shall be determined by measuring the volume displaced from the pump suction container to maintain ± 5 psi of the test pressure. The allowable rate of leakage shall be determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

in which:

- L = Allowable leakage (gallons/hour) during the test period.
- S = Length of pipe, in feet
- D = Diameter of the pipe (inches)
- P = Average test pressure (psig) maintained

3. The allowable leakage for chemical solution piping is zero. If the leakage exceeds the allowable amount or the test pressure varies more than plus or minus 5 psi, the test is considered failed. Should the test fail, the Contractor shall determine the reason(s) the test failed, correct the problems, and repeat the testing until the test passes.

**TABLE 15044
PIPING PRESSURE TEST SCHEDULE**

| Type of Piping | Identification | Test Pressure (in psig) |
|----------------------------------|-----------------|----------------------------|
| Potable, Raw, Chlorine, Fluoride | PW, RAW, CS, FL | 150 |

END OF SECTION

**SECTION 15062
DUCTILE IRON PIPE AND FITTINGS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish all labor, materials, equipment and incidentals required and install, all ductile iron piping, ductile iron fittings, and appurtenances as shown on the Drawings and as specified herein.
- B. General Design: The equipment and materials specified herein are intended to be standard types of ductile iron pipe and cast or ductile iron fittings for use in transporting potable water.

1.02 QUALITY ASSURANCE

- A. Qualifications: All of the ductile iron pipe and ductile or cast iron fittings shall be furnished by manufacturers who are fully experienced, reputable, and qualified in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.
- B. Standards:
 - 1. ANSI A 21.50/AWWA C150
 - 2. ANSI A-21.51/AWWA C151
 - 3. ANSI A-21.41/AWWA C104
- C. Factory Tests: The manufacturer shall perform the factory tests described in ANSI A-21.51/AWWA C151.
- D. Quality Control
 - 1. The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with the referenced standards. All pipe on this Project shall be supplied by a single manufacturer unless otherwise accepted in writing by the County.
 - 2. In addition to the manufacturer's quality control procedures, the County may select an independent testing laboratory to inspect the material at the foundry for compliance with these specifications. The cost of foundry inspection requested by the County will be paid for by the County.

1.03 SUBMITTALS

- A. Materials and Shop Drawings
 - 1. Submit Shop Drawings and piping layouts, including areas within and under buildings and structures. Shop Drawings shall include dimensioning, methods and locations of supports and all other pertinent technical specifications.

Show locations of all field cuts. Shop Drawings shall be prepared by the pipe manufacturer. Shop Drawings for piping within and under buildings and structures shall be submitted within 30-days of Execution of Contract.

- B. Operating Instructions: Submit Operation and Maintenance Manuals in accordance with Section 01001 "General Work Requirements."
- C. Manufacturer's Certification
 - 1. Submit manufacturer's sworn certification of factory tests and test results.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

The Contractor shall be responsible for all materials furnished and stored until the date of project completion. The Contractor shall replace, at his expense, all materials found to be defective or damaged in handling or storage. The Contractor shall, if requested by the County, furnish certificates, affidavits of compliance, test reports, samples or check analysis for any of the materials specified herein. All pipe delivered to project site for installation is subject to random testing for compliance with the designated specifications.

- A. Delivery and Storage: Delivery and storage of the materials shall be in accordance with the manufacturer's recommendations. Stored pipe shall be covered for protection against contamination and UV light. Joint gaskets shall be stored in clean, dark and dry location until immediately before use.
- B. Handling: Care shall be taken in loading, transporting and unloading to prevent damage to the pipe and fittings and their respective coatings. Pipe or fittings shall not be rolled off the carrier or dropped. Pipe shall be unloaded by lifting with a forklift or crane. All pipe or fittings shall be examined before installation and no piece shall be installed which is found to be defective. Pipe shall be handled to prevent damage to the pipe or coating. Accidental damage to pipe or coating shall be repaired to the satisfaction of the County or be removed from the job. When not being handled, the pipe shall be supported on timber cradles or on level ground, graded to eliminate all rock points and to provide uniform support along the full pipe length. When being transported, the pipe shall be supported at all times in a manner which will not permit distortion or damage to the lining or coating. Any unit of pipe that, in the opinion of the County, is damaged beyond repair by the Contractor shall be removed from the site.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ductile Iron Pipe
 - 1. Standards: ANSI A-21.50, AWWA C150 and ANSI A-21.51, AWWA C151
 - 2. Thickness/Pressure Class:
 - a. Below ground piping: Class 350 (4-inch to 12-inch), Class 250 (16-inch to 24-inch) and Class 200 (30-inch to 64-inch) unless otherwise noted or specified.

- b. Above ground piping: Flanged, Class 350 (minimum) unless otherwise noted or specified.
3. Joints
- a. Push-on or Mechanical Joints (below ground piping)
 - i. Standards: ANSI A21.11, AWWA C111
 - ii. Class: 350-psi working pressure rating
 - iii. Gaskets
 - I. Potable and Reclaimed Water Service: Styrene Butadiene Rubber (SBR) ring type.
 - b. Flanged (above ground or inside below ground vaults)
 - i. Standards: ANSI A21.15, ANSI B16.1
 - ii. Class: 125-pound factory applied screwed long hub flanges, plain faced without projection.
 - iii. Gaskets
 - I. Spans less than 10-feet: full-face 1/8-inch thick neoprene rubber
 - II. Spans greater than 10-feet: Toruseal gaskets as manufactured by American Cast Iron Pipe or acceptable equal.
 - c. Restrained Joints
 - i. Manufacturers: Lok-Ring system (all sizes) or locking type gasket systems (for 16-inch diameter and smaller) as manufactured by American Ductile Iron Pipe; MEGALUG System as manufactured by EBBA Iron; or acceptable equal.
 - ii. Class: 250-psi minimum design pressure rating.
 - iii. Standard mechanical joint retainer glands shall not be acceptable.
 - d. Joint Accessories
 - i. Mechanical joint bolts, washers and nuts: Ductile iron or Corten steel.
 - ii. Flanged joint bolts, washers and nuts: 316 stainless steel with bolts and nuts conforming to ASTM A193 Grade B8M.
 - e. Pipe Length (below ground installation): 20-foot maximum nominal length.
4. Pipe Identification
- a. Each length of pipe shall bear the name or trademark of the manufacturer, the location of the manufacturing plant, and the class or strength classification of the pipe. The markings shall be plainly visible on the pipe barrel. Pipe which is not clearly marked is subject

to rejection. The Contractor shall remove all rejected pipe from the project site within five NORMAL WORKING DAYS.

B. Fittings

1. Ductile iron fittings 4-inch through 24-inch shall be pressure rated at 350-psi minimum, except flanged joint type fittings which shall be rated at 250-psi minimum. All 30-inch and larger fittings shall be pressure rated to 250-psi minimum. All fittings shall conform to either ANSI/AWWA C110/A21.10 and/or C153/A21.53, latest revision, and shall be ductile iron only. All fittings shall be cast and machined allowing the bolt holes to straddle the vertical centerline. All fittings shall be designed to be capable to withstand, without bursting, hydrostatic tests of three times the rated water working pressure. All fittings shall have a date code cast (not printed or labeled) with identification of date, factory, and the factory unit from which it was cast and machined. Fittings shall have the pressure rating, nominal diameter of openings, manufacturer's name, and the country where cast and number of degrees or fraction of the circle distinctly cast on them. Ductile iron fittings shall have the letter "DI" or "Ductile" cast on them.
2. Joints shall be as described for ductile iron pipe for above ground/exposed and buried service.
3. All potable water main fittings shall have NSF 61 certification, and ISO 9001 certification for both the foundry and manufacturer. The NSF 61 certification shall be issued on all coatings and linings, from the said manufacturers that are used for potable water applications.

2.02 COATINGS, LININGS AND IDENTIFICATION MARKINGS

A. Exterior Coatings

1. Below ground/buried or in a casing pipe:
 - a. Type: Asphaltic coating, 1.0-mil DFT in accordance with ANSI/AWWA A21.51/C151.
 - b. Markings: (continuous 3-inch wide strip within top 90 degrees of pipe - min. drying time 30-minutes before backfill).
 - c. Color:
 - i. Potable Water: Safety Blue
2. Above ground/Exposed/In vaults
 - a. Coatings and coating testing for ductile iron pipe and fittings for above ground/exposed applications shall be accordance with Division 9. Primer, intermediate and final coats whether shop or field applied shall be compatible and applied in accordance with the coating system manufacturer's recommendations. Refer to Appendix D "List of Approved Products" for approved coating system suppliers. Asphaltic seal coat applied to the exterior of above ground piping and fittings shall be blasted and completely removed prior to coating per NACE-

3/SSPC-SP6 commercial blast cleaning minimum angular anchor profile of 1.5-mils.

- b. Color
 - i. Potable Water: Safety Blue

B. Interior Lining (Applied by pipe manufacturer)

- 1. Potable Water : Interior coating shall be Cement Mortar lined with asphaltic seal coat.
 - a. Cement mortar lining with a seal coat of asphaltic material shall be in accordance with ANSI/AWWA A21.4/C104.
- 2. Standard: ANSI A 21.5/AWWA C105, 8-mil minimum thickness.

2.03 LOCATION MARKERS AND LOCATION WIRE

A. Location Detection Wire

- 1. Materials: Continuous, insulated 10-gauge copper wire (color to match pipe identification).
- 2. Installation: Directly above (1-inch maximum) centerline of pipe terminating at top of each valve box collar and be capable of extending 12-inches above top of box (stored inside the 2-inch brass pipe through the valve box collar) in a manner so as not to interfere with valve operation. For direction drilling installations, a minimum of 2 (two) 10-gauge wires shall be pulled along with the pipe.
- 3. Continuity: Continuity of wire to be tested using Metrotech 810/9860 or acceptable equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ductile iron pipes shall be installed in accordance with AWWA C600 and AWWA Manual M-42. When a restraining type gasket is used, the bell shall be painted red.

B. Underground Ductile Iron Pipe and Fittings.

- 1. Bedding firm, dry and even bearing of suitable material. Blocking under the pipe will not be permitted.
- 2. Placement
 - a. Alignment: In accordance with lines and grades shown on the Drawings. Deflection of joints shall not exceed 75% of the values recommended by the pipe manufacturer.
 - b. The Contractor shall provide line and grade stakes at a 100-foot maximum spacing and at all line and/or grade change locations. The Contractor shall provide temporary benchmarks at a maximum of 1,000-foot intervals. The minimum pipe cover shall be 30-inches

- below the finished grade surface or 30-inches below the elevation of the edge of pavement of the road surface whichever is greater.
- c. All pipe and fittings shall be inspected prior to lowering into trench to insure no cracked, broken or otherwise defective materials are being used. All homing marks shall be checked for the proper length so as to not allow a separation or over homing of connected pipe. Homing marks incorrectly marked greater than 1-inch shall result in rejection of pipe and removal from site. The Contractor shall clean ends of pipe thoroughly and remove foreign matter and dirt from inside of pipe and keep clean during and after installation.
 - d. Proper implements, tools and facilities shall be used for the safe and proper protection of the Work. Pipe shall be lowered into the trench in such a manner as to avoid any physical damage to the pipe. Pipe shall not be dropped or dumped into trenches under any circumstances.
 - e. Trench Dewatering and Drainage Control: Contractor shall prevent water from entering trench during excavation and pipe-laying operations to the extent required to properly grade the bottom of the trench and allow for proper compaction of the backfill. Pipe shall not be laid in water.
 - f. Pipe Laying in Trench: Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned and re-laid. Pigging of pipe may be used to remove foreign materials in lieu of flushing. At times when pipe installation is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the County to ensure absolute cleanliness inside the pipe. The pipe shall be installed with the color stripe and pipe text on the top of pipe.
3. Cutting: When required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a push-on bell shall be beveled. Bare metal exposed at ends of the pipe shall be field coated in accordance with pipe manufacturer's recommendations.
 4. Joints
 - a. Joint Placement
 - i. Push on joints: Pipe shall be laid with the bell facing upstream. The gasket shall be inserted and the joint surfaces cleaned and lubricated prior to placement of the pipe. After joining the pipe, a metal feeler shall be used to verify that the gasket is correctly located.
 - ii. Mechanical Joints: Pipe and fittings shall be installed in accordance with the "Notes on Method of Installation" under ANSI A21.11/AWWA C111. The gasket shall be inserted and the joint surfaces cleaned and lubricated with soapy water before tightening the bolts to the specified torque.

C. Thrust Restraint

1. General: Thrust restraint shall be accomplished by the use of mechanical restraining devices unless specifically identified otherwise on the Drawings or herein.
2. Length of Restrained Joints: All pipe joints for all water, reclaimed water and force main pipes shall be restrained.

D. Installation of Pipes on Curves

1. Maximum deflections at pipe joints, fittings and laying radius for the various pipe lengths shall not exceed 75% (percent) of the pipe manufacturer's recommendation.

E. Polyethylene encasement: See paragraph 2.02C. Installation shall be in accordance with pipe manufacturer's instructions.

3.02 CLEANING AND FIELD TESTING

- A. General: At the conclusion of the Work, the Contractor shall provide all associated cleaning and field testing as specified in other related sections of these specifications.

END OF SECTION

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**SECTION 15100
ANCILLARY EQUIPMENT**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Provide all valves and appurtenances, ready for operation, as shown on the Drawings and as specified herein.

1.02 QUALITY ASSURANCE

- A. All valves, appurtenances, and ancillary equipment shall be products of well-established reputable firms who are fully experienced, reputable and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.03 SHOP DRAWINGS AND SUBMITTALS

- A. Submittals shall be submitted to the County for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 "Submittals."

PART 2 - PRODUCTS

2.01 GENERAL

- A. All valves, appurtenances, and ancillary equipment shall be of the sizes shown on the Drawings and specified herein.
- B. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
- C. All valves, appurtenances, and ancillary equipment shall be as specified in Appendix D "List of Approved Products" appended to these technical specifications.

2.02 AIR RELEASE VALVES

- 1. Valves shall be combination type and have a working pressure rating of at least 200 psi. Valve End Connections:
 - a. Valves smaller than 3 inches shall have a threaded opening. Valves 3 inches or larger shall have a flanged opening.
 - b. Flanges for Class 150 valves shall comply with ANSI B16.1, Class 125. Flanges for Class 300 valves shall comply with ANSI B 16.1, Class 250.
 - c. Threaded openings shall comply with ANSI B2.1
 - d. All air release valves shall be isolated from the service line with a 316 stainless steel ball valve.

2. Potable water air release valves shall be per the Orange County Utilities list of approved manufacturers listed in "Appendix D" of the OCU Standards and Construction Specification Manual.
3. Air release valves located at each vertical turbine raw water well pump shall consist of a ductile iron body, 316 stainless steel floats, and be rated for 150 psi. Well pump air release valves shall be Val-matic Well Service Air Valves.

2.03 TAPPING SLEEVES AND VALVES

- A. General: Tapping sleeves shall be mechanical joint sleeves.
- B. Mechanical Joint Sleeves: Sleeves shall be cast of gray-iron or ductile-iron and have an outlet flange with the dimensions of the Class 125 flanges shown in ANSI B16.1 and properly recessed for tapping valve. Glands shall be gray-iron or ductile iron. Gaskets shall be vulcanized natural or synthetic rubber. Bolts and nuts shall comply with ANSI/AWWA C111/ANSI A21.11. Sleeves shall be capable of withstanding a 200-psi working pressure.
- C. Fabricated Mechanical Joint Tapping Sleeves: Sleeves shall be of split mechanical joint design with separate end and side gaskets. Sleeves shall be fabricated of high strength steel, meeting ASTM A283 Grade C or ASTM A-36. Outlet flange shall meet AWWA C-207, Class "D" ANSI 150-pound drilling and be properly recessed for the tapping valve. Bolts and nuts shall be high strength low alloy steel to AWWA C111 (ANSI A21.11). Gasket shall be vulcanized natural or synthetic rubber. Sleeve shall have manufacturer applied fusion-bonded epoxy coating, minimum 12-mil thickness.
- D. Tapping Valves: Tapping valves shall be resilient seated gate valves flange by mechanical joint ends. Valves shall be compatible with tapping sleeves as specified above and specifically designed for pressure connection operations.
 1. Tapping valves with alignment lip shall be placed vertical where possible for Water and Reclaimed Water.
 2. Tapping Valves 16-inch and larger shall be AWWA C515 resilient seated only (16-inch and 24-inch no gearing required) above 24-inch shall be installed vertically with a spur gear actuator. When tapping existing mains, valves 24-inch and above shall be furnished with NPT pipe plugs for flushing the tracks.

2.04 VALVE BOXES FOR BURIED VALVES

- A. Standard 2-piece Cast Iron Valve Box: Required for mains less than 6-feet below finished grade and less than or equal to 12-inches in diameter.
 1. Valve boxes shall be provided with suitable heavy bonnets and shall extend to such elevation at or slightly above the finished grade surface as directed by the County's Representative.

2. The barrel shall be 2-piece, screw type only, having 5-1/4-inch shaft. The upper section shall have a flange at the bottom having sufficient bearing area to prevent settling and shall be complete with locking cast iron covers. Coat buried cast iron pieces with coal tar epoxy.
- B. Valve Box Assembly: Valve box assemblies with operating nut extension is required for any size main that is 6-feet or greater below finished grade or if mains are greater than 12-inches in diameter.
1. Valve boxes shall be 1 complete assembled unit composed of the valve box and extension stem that attaches and locks to the 2-inch wrench nut. The extension shall be high strength, corrosion resistant steel construction, and permanently attached to the operating nut.
 2. The operating nut extension insert shall be 1 complete assembled unit with a self-adjusting extension stem system that fits inside a standard valve box that will accommodate variable trench depths 6-feet and greater as shown in the Drawings. All moving parts of the extension stem shall be enclosed in a housing to prevent contact with the soil.
 3. A valve box-centering device designed to eliminate the shifting of the valve box against the operating nut of the valve shall be used. Valve box assembly shall be adjustable to accommodate variable trench depths 6-foot and greater as shown in the Drawings.
- C. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The material shall be at minimum galvanized square steel tubing. The stem assembly shall have a built-in device that prevents the stem assembly from disengaging at its fully extended length. The extension stem must be capable of surviving a torque test to 1,000-foot-pounds without failure.
- D. Valve boxes shall have locking cast iron covers utilizing a 5-sided nut with a special wrench needed to open. Covers shall have "WATER", "SEWER", or "RECLAIMED WATER" cast into the top, as applicable
- E. Concrete Collar: Each valve installed in an unimproved area (outside of pavement, driveways or sidewalks) shall require a 24-inch by 24-inch by 6-inch concrete pad or collar as shown in the Drawings.
- F. Identification Disc: Each 16-inch or larger valve (unless otherwise shown on the Drawings) installed shall be identified by a 3-inch diameter bronze disc anchored in the concrete pad or collar in unimproved areas and/or anchored on a 4-inch by 4-inch by 18-inch long concrete post set flush with the pavement surface in improved areas. The disc shall be stamped with the following information as shown on the Drawings:
1. Size of the valve
 2. Type of valve
 3. Service
 4. Valve ID #
 5. Direction and number of turns to open

- G. Valve markers are to be made of schedule 80 PVC and have decal applied containing information as shown on the Drawings. The marker shall be the same color as the pipe being marked.

2.05 LINE STOPPING ASSEMBLIES

- A. Sleeves used to line-stop existing mains shall be provided and installed at locations as shown on the Drawings. Line-stopping sleeve shall be steel fusion epoxy coated body with stainless steel straps, bolts, nuts, and washers. Contractor shall determine the outside diameter of the existing main prior to ordering sleeve.
- B. The line-stopping equipment shall consist of a resilient sealing element, which shall be attached to and transported by a plug inserter perpendicularly into the pipe. The linear actuator shall extend and retract the Line-Stopper into and out of the pipe. When retracted from the pipe, the element and inserter shall be contained within the stopper housing.
- C. The hollow cylindrical sealing element shall be molded of natural rubber. The lower interior chamber of the element shall be enlarged into a hemispherical cavity to allow symmetrical deformation into sealing conformity with the bore of the pipe.
- D. The linear actuator shall be hydraulic and shall have a self-contained hand operated pump. The actuator shall exert a force sufficient to perpendicularly deform the cylindrical element into axially symmetrical sealing contact with the bore of the pipe. Design of actuator shall provide adequate stroke and means to continually align the line-stop bullet stopping assemblies in sizes 14-inch through 20-inch with pressure rating to 250-psig.
- E. Equalization of pressure across the sealed element shall not be required to retract the element from the pipe. No equalization fittings shall be required downstream of the line-stopper.
- F. The line-stopping equipment shall be accurately aligned on the 4-inch through 8-inch fittings by locating in the external threads of the fitting nozzle. With sizes 10-inch and 12-inch the location shall be made on the centering groove of the fitting flange.
- G. Line-stopping equipment must be capable of function and acceptance of multiple stopper heads and shall be compatible with existing system fittings.

2.06 FIRE HYDRANTS AND VALVE ASSEMBLIES

- A. Fire hydrants shall be 5-1/4-inch minimum valve opening and shall comply with the current AWWA Standard Specifications C502-54 for 150-psi working pressure. Fire hydrants shall be of ample length for 3-1/2-foot depth of bury with necessary extensions to place safety flange the required 3-inches above finished grade. Each hydrant shall be made in at least 2 sections bolted together. All interior working parts of the hydrant shall be removable from the top of the hydrant to allow repairs without removing the hydrant barrel after it has been installed. It shall be provided with 2 (two) 2-1/2-inch hose nozzles and 1 (one) 4-1/2-inch pumper nozzle, all having its specific Fire District Standard hose threads. All nozzles shall have caps attached by

chains. Operating nuts shall be AWWA Standard. Drain or weep holes shall be permanently plugged by the manufacturer.

- B. Fire hydrant painting and coating shall meet the requirements of Section 09900 "Painting." Fire hydrants shall be painted silver in accordance with the present Orange County standards. Three (3) operating wrenches shall be furnished for every 10 hydrants installed or relocated.
- C. All hydrant assemblies shall incorporate anchoring hydrant fittings, including M.J. Locked Hydrant Tee with split gland to provide the locking together of the entire assembly. Gate valve shall be as specified in Specification Section 15111 "Gate Valves."
- D. All hydrants shall have a 24-inch to 48-inch square by 6-inch thick reinforced concrete shear pad as shown in the Drawings.
- E. Fire hydrants shall be located in the general location as shown on the Drawings. Final field location of all hydrants shall be as approved by the County. All hydrants shall be located no less than 5 and no more than 10-feet from the edge of pavement of the adjacent roadway and no less than 5-feet from any physical feature which may obstruct access or view of any hydrant unless otherwise approved by the County.
- F. Provide (2) fire hydrant wrenches.

2.07 SERVICE SADDLES

- A. Stainless Steel Service Saddles: Shall be epoxy or nylon coated ductile iron body with stainless steel, 18-8 type 304 straps, AWWA tapered threads for 1-inch and 2-inch to be iron pipe threads. Controlled OD saddles to be used on C905 PVC pipe, double straps to be 2-inch minimum width each, single strap to be minimum of 3-inches wide.
- B. PVC Pipe Service Saddle
 1. One-inch and 2-inch services utilize brass body saddle with controlled OD for 12-inches and smaller pipe.
 2. One-inch and 2-inch taps on existing pipes larger than 12-inches shall use controlled OD epoxy or nylon coated ductile iron body with stainless steel 18-8 type 304 straps.
 3. Four-inch or larger services shall be mechanical tapping sleeves.
- C. Ductile Iron Pipe Service Saddle
 1. One-inch services shall be direct tapped.
 2. Two-inch service shall use a controlled OD service tapping saddle with stainless steel straps and a ductile iron body that is either nylon or epoxy coated
 3. Four-inch or larger services shall be mechanical tapping sleeves.
- D. HDPE Pipe Service Saddle

1. One-inch and 2-inch shall utilize controlled O.D. tapping saddle with epoxy or nylon coated stainless steel 18-8 type 304 double straps.
 2. Four-inch or larger, shall use wide body tapping sleeves with a broad cross section gasket set in a retaining groove that increases sealing capability as pressure increases.
- E. Concrete Pressure Pipe Service Saddle
1. Tapped concrete pressure pipe shall be in accordance with AWWA M-9, using a strap-type saddle made specifically for concrete cylinder pressure pipe.
- F. Steel Pipe Service Saddle
1. Welded-on steel sleeves shall be used for all sizes and applications.

2.08 CORPORATION STOPS AND CURB STOPS

- A. Corporation Stops: Shall be brass body reduced port type compatible with the polyethylene tubing and threaded in accordance with AWWA C800, AWWA C901, and shall comply with NSF-61.
- B. Curb Stops: Shall be brass body reduced port type compatible with the polyethylene tubing and threaded in accordance with AWWA C800, AWWA C901, and shall comply with NSF-61.

2.09 WATER MAIN SERVICE PIPE

- A. Polyethylene Service Pipe: One-inch and 2-inch service lines shall be polyethylene tubing conforming to AWWA C901 and AWWA C800. Tubing shall be approved for potable water use and bear the seal of the National Sanitation Foundation (NSF). The product shall be rated for a minimum working pressure of 150-psi and a (Dimension Ratio) DR-9 size. The tubing shall be designated copper tube size and the material PE-2406 cell classification minimum PE213323C in accordance with ASTM 3350.
- B. Ductile Iron Service Pipe: Services 4-inch and larger shall be DIP. If the existing main is on the same side of the street as the property to be serviced, the service pipe shall be DIP from the point of connection to the existing main to the meter assembly. If the existing main is on the opposite side of the street as the property to be serviced, at a minimum, the segment of pipe immediately upstream from the meter assembly shall be DIP.
- C. No service pipe shall terminate under a driveway.

2.10 PRESSURE GAUGES

- A. Pressure gauges shall be installed on each pump's discharge and suction piping as indicated on the Drawings.

- B. Pressure gauge shall be direct mounted, diaphragm (type) gauge, stainless steel case, stainless steel sensing element, liquid filled, with a 4-1/2-inch diameter dial and furnished with a clear glass crystal window and 1/4-inch shut-off (isolation) valve. Gauges shall be weatherproof.
- C. The pressure gauge face dial shall be white finished aluminum with jet-black graduations and figures and shall indicate the units of pressure measured in psi. Gauges shall be provided with pressure at normal operation at the mid range of the gauge.
- D. As water flows through the housing, the cylinder shall transmit pressure through the sensing liquid. Gauge outlet in the spool or ring shall be threaded, 1/4-inch, per ANSI B2.1.
- E. Nipples for connecting gauges to piping shall be Schedule 80S, Grade TP 316 seamless stainless steel, conforming to ASTM A 312. Fittings shall conform to ASTM A 403, Class WP316. Threads shall conform to ANSI B2.1. Size of pipe nipple shall match the gauge connection size.

2.11 TIE RODS

- A. Steel for tie rods and tie bolts shall conform to the requirements of ASTM Designation A 242, and rods shall be galvanized in conformance with requirements of ASTM Designation A 123.

2.12 BACK FLOW PREVENTION

- A. Reduced Pressure Backflow Preventer shall conform to the requirements of ASSE 1013, rated to 180°F and supplied with full port ball valves. The main body and access covers shall be bronze and meet ASTM B 584, the seat ring and all internal polymers shall be NSF Noryl and the seat disc elastomers shall be silicone.
- B. Dual check valves shall be required and shall be accessible for maintenance without removing the relief valve or the entire device from the line.
- C. The bottom of the preventer shall be installed a minimum of 12-inches above grade and not more than 30-inches above grade.

2.13 FLANGED COUPLING ADAPTERS

- A. All adapters shall be harnessed with the bolts across the joint (flange to flange or flange to lug) designed for the pipe test pressure.
- B. Adapter Size: Conform in size and bolt hole placement to ANSI standards for steel and/or cast iron flanges 125 or 150-pound standard unless otherwise required for connections.
- C. Exposed Sleeve Type
 1. Material: Steel
 2. Coating: Enamel
 3. Bolting: Carbon steel

4. Acceptable Manufacturers: Dresser Manufacturing Co. - Style 128 for cast iron ductile iron and steel pipes with diameters of 2-inches through 96-inches, or equal.
- D. Buried Sleeve Type
1. Material: Cast iron
 2. Bolting: Type 304 stainless steel conforming to ASTM A 193, Grade B8 for bolts, and ATM A 194, Grade 8 for nuts and washers. Bolts and nuts greater than 1-1/8-inches shall be carbon steel, ASTM A 307, Grade B, with cadmium plating, ASTM A 165, Type NS.
 3. Acceptable manufacturers: Dresser Manufacturing Co. - Style 127 locking type for cast iron, ductile, iron, asbestos cement and steel pipes with diameters of 3-inches through 12-inches, or equal.
- E. Split Type
1. Material: Malleable or ductile iron.
 2. Design: For use with grooved or shouldered end pipe.
 3. Coating: Enamel
 4. Acceptable Manufacturers: Victaulic Company of America - Style 741 for pipe diameters of 2-inches through 12-inches, Victaulic Company of America - Style 742 for pipe diameters of 14-inches through 16-inches, or equal.

2.14 HOSE BIBBS

- A. Hose bibs shall be brass, heavy duty, 2002 HD with 72001 vacuum breaker by A.Y. McDonald or equal.

2.15 PIPE AND VALVE IDENTIFICATION

- A. Identification systems for above-ground and below-ground valves shall be as specified in Section 09905.

2.16 EXPANSION JOINTS FOR HIGH SERVICE PUMPS

- A. Expansion joints shall be of the molded wide single arch design manufactured of neoprene rubber with polyester and steel reinforcement. Neoprene body shall be supplied with a hypalon coating. joints shall be flanged suitable for 150 psi water working pressure and in accordance with ANSI B16.1 dimensions and bolting patterns. flanged ends shall be furnished with 316 stainless steel retaining rings.
- B. Provide limit restraint bolts on all lines. Expansion joints 6 inches and larger in size shall have a minimum of four limit restraint bolts. Restraint bolts and nuts shall be type 316 stainless steel.
- C. Expansion joints shall be Redflex as manufactured by Redvalve, style 1015, Maxi-joint as manufactured by General Rubber Corporation, style 100, Metrasphere as manufactured by the Metraflex company, or approved equal.

2.17 JOINT RESTRAINTS

A. Mechanical Joints

1. Joint restraints for mechanical joint fittings 3” through 48” shall be constructed of ductile iron conforming to ASTM A536 and shall have a working pressure rating of 350 PSI for 3–16 inch fittings and 250 PSI for 18-48 inch fittings.
2. Restraint shall be accomplished by multiple gripping wedges incorporated into a follower gland meeting the requirements of ANSI/AWWA C110/A21.10.
3. Restraints shall be Megalug Series 1100 restraints with Mega-Bond coating as manufactured by EBBA Iron or approved equal.

B. Pipe Joints

1. Joint restraints for push-on pipe joints 3” through 48” shall be constructed of ductile iron conforming to ASTM A536 and shall have a working pressure rating of 350 PSI for 3–16 inch fittings and 250 PSI for 18-48 inch fittings.
2. Restraint shall be accomplished by a wedge action restraint ring on the spigot joined to a split ductile iron ring behind the bell. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges.
3. Restraints shall be Megalug Series 1700 Megalug restraint harnesses with Mega-Bond coating as manufactured by EBBA Iron or approved equals.

2.18 PVC BALL VALVES

- A. PVC ball valves shall be of one piece capsule type manufactured of Type 1, Grade 1 PVC. Ball valves shall be true union design with two-way blocking capability and shall have solvent welded socket ends. Vented PVC ball valves shall be furnished for sodium hypochlorite services.
- B. Ball valves shall have Teflon seats with Viton backing cushions and Viton O-ring seals, and shall be designed for a 150 psi working pressure at 120°F. Valves shall be supplied with ABS lever operating handles.
- C. PVC ball valves shall be Type 21 manufactured by Asahi/America, or an equal approved by the Engineer.

2.19 STAINLESS STEEL BALL VALVES

- A. Stainless steel ball valves shall be standard port type for the sizes indicated on the Drawings. Ball valves shall be designed for a working pressure of 200 psi with positive shut off when in the closed position.
- B. Valve body and ends shall be constructed of forged Type 316 stainless steel and valve ends shall be NPT threaded connections. The ball shall have a full bore port design machined from a solid metal piece with highly polished surfaces. The ball and stem shall be manufactured from Type 316 stainless steel.

- C. Manually operated ball valves shall be furnished with level operators manufactured of forged Type 316 stainless steel with a molded vinyl sleeve. Stainless steel ball valves shall be Type 1000 Neles-Jamesbury screwed end ball valves, or an approved equal.

2.20 SOLENOID VALVES

- A. Solenoid valves for water and fluoride service shall be 2-way type for normally closed operation designed for not less than a 150 psi water working pressure with a PVDF body. Valves shall have NPT threaded ends with a PVC union provided on each side for easy removal, PTFE seals/disks, and NEMA 4X solenoid enclosures. The valves shall operate on 24 VDC power, shall have threaded conduit hubs, standby manual operators and shall not require minimum operating pressure differential for steady operation. The valves shall be manufactured by Plast-O-Matic, or approved equal.

2.21 STRAINERS

- A. Strainers shall be true union Y-type manufactured of transparent Type 1, Grade 1 PVC with solvent welded socket ends. Screen for strainers shall be 20 mesh PVC. The screen shall be easily removed for cleaning or replacement from the filter body without removing the body from the pipeline. All seals and o-rings shall be Viton. The sediment strainers shall have a 150 psi pressure rating. Strainers shall be manufactured by Asahi/America, or an approved equal.

2.22 PVC BALL CHECK VALVES

- A. PVC ball check valves shall be of a solid thermoplastic construction manufactured of Type 1, Grade 1 PVC. Ball check valves shall be true union design with solvent welded socket or NPT threaded ends.
- B. Ball check valves shall be furnished with a solid thermoplastic ball and stainless steel spring to assist ball in seating faster. Ball seat shall be Teflon-coated Viton. The same seal shall function as both the ball seat and the union seal. PVC ball check valves shall be designed for a 150 psi water working pressure at 120°F.
- C. Valves shall be manufactured by Asahi/America, or approved equal.

2.23 LINE STOPS

- A. Line stops shall consist of a line stop fitting, stopping plug/valve, blind flange for installation after stop is completed, and 1-inch equalization/purge fitting.
- B. The line stop fitting shall be fabricated steel with 12 mil (minimum) epoxy coating.
- C. All hardware and accessories shall be 304 Stainless Steel.
- D. The blind flange shall be ductile iron conforming to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53
- E. Provide additional pipe restraining in the vicinity of the line stop for preventing pipe movement due to any unbalanced forces created by the line stop installation and removal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All ancillary equipment shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the County before installation.
- B. After installation, all ancillary equipment shall be tested as specified for adjacent piping. If any joint or equipment proves to be defective, it shall be repaired and retested to the satisfaction of the County.
- C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures, which have a direct bearing on the location and shall be responsible for the proper location of these valves and appurtenances during the Construction of the structures.
- D. Notification and Connections to Existing Mains
 - 1. The Contractor shall submit a completed "System Connection" form to the County to schedule the connection. The request shall be made a minimum of 5-working days prior to the proposed tie-in to the existing main for pressure connections and 10-working days prior to the proposed tie-in to the existing main for non-pressure connections. In this request, the Contractor shall provide the following information:
 - a. Points of connection, fittings to be used and method of flushing and disinfection if applicable
 - b. Estimated construction time for said connections
 - c. Identify pressure and non-pressure connections
 - 2. Connections shall only be made on the agreed upon date and time. If the Contractor does not perform the Work in the agreed upon manner or schedule, the Contractor shall be required to reschedule the connection by following the procedure outlined above.
- E. Pressure Connections: Sufficient length of main shall be exposed to allow for installation of the tapping sleeve and valve and the operation of the tapping machinery. The main shall be supported on concrete pedestals or bedding rock at sufficient intervals to properly carry its own weight, plus the weight of the tapping sleeve, valve and machinery. Any damage to the main due to improper or insufficient supports will be repaired at the Contractor's expense.
 - 1. Prior to the tap, the Contractor shall assemble all materials, tools, equipment, labor, and supervision necessary to make the connection.
 - 2. The Contractor shall excavate a dry and safe working area pit of sufficient size to enable the necessary Work.

3. The inside of the tapping sleeve and valve, the outside of the main and the tapping machine shall be cleaned and swabbed or sprayed with 1% liquid chlorine solution prior to beginning installation for water system pressure connections and must comply with AWWA C-651-99 or most current version.
 4. After the tapping sleeve has been mounted on the main, the tapping valve shall be bolted to the outlet flange, making a pressure tight connection. Prior to beginning the tapping operation, the sleeve and valve shall be pressure tested under the observation of County personnel to 150-psi for 30-minute duration to ensure that no leakage will occur.
 5. For pressure connections 4-inch through 20-inch installation, the minimum diameter cut shall be 1/2-inch less than the nominal diameter of the pipe to be attached. For larger taps, the allowable minimum diameter shall be 2 to 3-inches less than the nominal diameter of the pipe being attached. After the tapping procedure is complete, the Contractor shall submit the coupon to the County.
 6. The tapping valve shall be placed horizontally for pressure connections to water force mains. A plug valve shall be attached to the tapping valve after the tapping procedure is complete. The tapping valve shall be left in the open position prior to backfilling.
 7. Adequate restrained joint fittings shall be provided to prevent movement of the installation when test pressure is applied.
 8. The Contractor shall be responsible for properly backfilling the work area pit after the Work is completed.
- F. Non-Pressure Dry Connections
1. For water service connections, no customer shall be without service for more than 6-hours. For water service connections, provide bypass operations per Section 01516 "Collection System Bypass." This accommodation to customers may include scheduling after Normal Working Hours.
 2. The Contractor shall be ready to proceed by pre-assembling as much material as possible at the site to minimize the length of service interruption.
 3. Needed pipe restraints must be installed prior to the initiation of the shutdown.
 4. The excavation shall be opened and needed site preparations must be completed before the initiation of the connection work.
 5. County shall postpone a service cut-off if the Contractor is not ready to proceed at the scheduled time.
 6. Only County personnel shall operate the valves needed to perform the shutdown on the existing system.
- G. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections in Division 15.

- H. Flanged joints shall be made with 304 stainless steel bolts, nuts and washers, unless otherwise noted. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint, Tnemec Series 46 – 465, Carboline Bitumastic 50, or equal.
- I. Clean iron flanges by wire brushing before installing flanged valves. Clean threaded joints by wirebrushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
- J. Expansion and Contraction Provisions
 - 1. Rigidly support all piping with adequate provisions for expansion and contraction.
 - 2. Firmly anchor horizontal runs over 50 feet in length at the midpoint of the runs to force expansion equally toward the ends.

3.02 PAINTING

- A. All exterior surfaces of iron body valves shall be clean, dry, and free from rust and grease before coating.
- B. For valves installed underground or in valve vaults, all exterior ferrous parts of valve and actuator shall be coated at the factory with a thermally bonded epoxy coating in accordance with AWWA C550, latest revision.
- C. For aboveground service, the exterior ferrous parts of all valves shall be coated in weatherproof paint per Section 09900. The color of the finish coats shall be in accordance with the Orange County Utilities Standards.

END OF SECTION

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**SECTION 15105
CHECK VALVES**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Scope of Work: Furnish, install, and test check valves including all appurtenances required as shown on the Drawings and as specified herein.
- B. General Design
 - 1. Valves larger than 2-1/2-inch diameter shall meet or exceed the requirements of AWWA C-508.
 - 2. All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of sewage, water, sludge, chemicals, air, etc., depending on the applications.
 - 3. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
 - 4. For all buried valves in which the operating nut is deeper than 4-feet from the finish ground surface, an extension rod with 2-inch operating nut and upper guide shall be installed permanently in the riser section. Extend nut to 1-foot below finish grade.

1.02 QUALITY ASSURANCE

- A. All gate valves of same type and style shall be manufactured by one manufacturer.
- B. All equipment furnished under this Specification shall be new and unused and shall be a standard product which has a successful record of reliable service in similar installations for a minimum of 5-years.

1.03 SHOP DRAWINGS AND SUBMITTALS

- A. Submittals shall be submitted to the County/Professional for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 "Submittals."
- B. Shop Drawings and submittals shall be submitted to the County/Professional Engineer for review and acceptance prior to construction for the following:
 - 1. Certified Shop Drawings showing details of construction, dimensions (including laying length), and weight.
 - 2. Descriptive literature, bulletins, and/or catalogs showing all valve parts and describing material of construction by material and specification, e.g., AISI.
 - 3. Valve coatings and linings, if any.
 - 4. A complete bill of materials for all equipment.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Shipping

1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed.
2. Factory assembled parts and components shall be dismantled for shipment unless permission is received in writing from the County/Professional Engineer.
3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
5. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.
6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage

1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.
2. Do not store valves or accessories directly on the ground.

C. Handling

1. Handle valves and accessories to prevent damage of any nature.
2. Carefully inspect all materials for:
 - a. Defects in workmanship and materials
 - b. Removal of debris and foreign material in valve openings and seats
 - c. Proper functioning of all operating mechanisms
 - d. Tightness of all nuts and bolts

1.05 WARRANTY AND GUARANTEES

- A. The manufacturer's warranty period shall be concurrent with the Contractor's for 1-year, unless otherwise specified, commencing at the time of final acceptance by the County.
- B. The Contractor shall be responsible for obtaining certificates for equipment warranty for all equipment which lists for more than \$500.00 (major equipment). The County reserves the right to request warranties for equipment not classified as "major". The Contractor shall still warrant equipment not considered to be "major" in the Contractor's 1-year warranty period even though certificates of warranty may not be required.

- C. In the event that the equipment manufacturer or supplier is unwilling to provide a 1-year warranty commencing at the date of substantial completion, the Contractor shall obtain from the manufacturer a 2-year warranty commencing at the time of equipment delivery to the job site. This 2-year warranty from the manufacturer shall not relieve the Contractor of the 1-year warranty starting at the time of County acceptance of the equipment.
- D. The County shall incur no labor or equipment cost during the guarantee period.
- E. Guarantee shall cover all necessary labor, equipment, and replacement parts resulting from faulty or inadequate design, improper assembly or erection, defective workmanship and materials, leakage, breakage, or other failure of equipment or components furnished by the manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Ball Check Valves, 2-1/2-inches and smaller.
 - 1. Valves shall be all bronze construction with screwed ends.
 - 2. Minimum valve working pressure shall be 150-psi.
 - 3. Valves shall be as manufactured by American Flow Control, Clow, Mueller, or approved equal.
- B. Swing Check Valves
 - 1. Swing check valves shall conform to AWWA C508.
 - 2. The valve body shall be 2-piece cast iron conforming to ASTM A126 with flanged ends conforming to ANSI B16.1. The area throughout the valve body shall be equal to the full pipe area.
 - 3. The valve disc shall be ductile iron with bronze or resilient seating face. The disc shall be partially balanced with a short travel to resist slamming.
 - 4. The seat ring and disc ring shall be ASTM B763 Alloy 84400 bronze, with beveled edges, firmly clamped or screwed into the valve body. Seat rings and disc rings shall be field replaceable.
 - 5. The hinge pin shall be of stainless steel with bronze bushings, allow free movement of the disc without binding, and shall be guaranteed not to stick in the closed position.
 - 6. The valve shall be designed for a minimum working pressure of 150-psi.
 - 7. Valves shall be supplied with an outside lever and adjustable weight.
 - 8. Valves 4-inches and larger shall be 8-mil epoxy lined.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valves and accessories in strict accordance with manufacturer's instructions and recommendations, as shown on the Drawings and/or as directed by the Owner.
- B. Carefully erect all valves and support them in their respective positions free from distortion and strain.
- C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
- D. Support all valves connected to pumps and equipment, and in piping systems that cannot support valves.
- E. Repair any scratches, marks and other types of surface damages, etc., with original prime coating as supplied by the factory.
- F. Apply finish coating in accordance with Division 9.

3.02 DEMONSTRATION AND TESTING

- A. Demonstration, start-up (adjustment) and testing shall demonstrate that all valves have been properly installed and that check valves operate properly.

END OF SECTION

**SECTION 15111
GATE VALVES**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: Furnish and install gate valves of the type and size and in the locations as shown on the Drawings and/or specified herein.
- B. General Design
 - 1. Resilient seat non-rising stem (NRS) gates valves shall be used for underground service and for aboveground service where shown on the Drawings.
 - 2. Resilient seat Outside Stem and Yoke (OS&Y) gate valves shall be used for aboveground service only where shown on the Drawings.

1.02 QUALITY ASSURANCE

- A. All gate valves of same type and style shall be manufactured by one (1) manufacturer.

1.03 SHOP DRAWINGS AND SUBMITTALS

- A. Submittals shall be submitted to the County/Professional for review and acceptance prior to construction in accordance with the General Conditions and specifications Section 01300 "Submittals."
- B. Shop Drawings and submittals shall be submitted to the County/Professional Engineer for review and acceptance prior to construction for the following:
 - 1. Certified Shop Drawings showing details of construction, dimensions (including laying length), and weight.
 - 2. Descriptive literature, bulletins, and/or catalogs showing all valve parts and describing material of construction by material and specification, e.g., AISI.
 - 3. Valve coatings and linings, if any.
 - 4. A complete bill of materials for all equipment.
 - 5. See individual sections for additional requirements.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Shipping
 - 1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed.
 - 2. Factory assembled parts and components shall be dismantled for shipment unless permission is received in writing from the County/Professional Engineer.

3. Finished surfaces of all exposed openings shall be protected by wooden blanks, strongly built and securely bolted thereto.
4. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
5. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.
6. Each box or package shall be properly marked to show its net weight in addition to its contents.

B. Storage

1. Store valves and accessories in an area on the construction site protected from weather, moisture, or possible damage.
2. Do not store valves or accessories directly on the ground.

C. Handling

1. Handle valves and accessories to prevent damage of any nature.
2. Carefully inspect all materials for:
 - a. Defects in workmanship and materials.
 - b. Removal of debris and foreign material in valve openings and seats.
 - c. Proper functioning of all operating mechanisms.
 - d. Tightness of all nuts and bolts.

1.05 WARRANTY AND GUARANTEES

- A. The manufacturer's warranty period shall be concurrent with the Contractor's for 1-year, unless otherwise specified, commencing at the time of final acceptance by the County.
- B. The Contractor shall be responsible for obtaining certificates for equipment warranty for all equipment which lists for more than \$500.00 (major equipment). The County reserves the right to request warranties for equipment not classified as "major". The Contractor shall still warrant equipment not considered to be "major" in the Contractor's 1-year warranty period even though certificates of warranty may not be required.
- C. In the event that the equipment manufacturer or supplier is unwilling to provide a 1-year warranty commencing at the date of substantial completion, the Contractor shall obtain from the manufacturer a 2-year warranty commencing at the time of equipment delivery to the job site. This 2-year warranty from the manufacturer shall not relieve the Contractor of the 1-year warranty starting at the time of County acceptance of the equipment.
- D. The County shall incur no labor or equipment cost during the guarantee period.
- E. Guarantee shall cover all necessary labor, equipment, and replacement parts resulting from faulty or inadequate design, improper assembly or erection, defective

workmanship and materials, leakage, breakage, or other failure of equipment or components furnished by the manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All material supplied shall be one of the products specified in Appendix D "List of Approved Products" appended to these technical specifications.

2.02 MATERIALS

- A. Gate valves shall be resilient seat gate valves, manufactured to meet or exceed the requirements of AWWA C509/C515, latest revision, and these Specifications. All valves are to be tested in strict accordance with AWWA C509/C515.
- B. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.
- C. The minimum design working water pressure shall be minimum 250-psig.
- D. Gate valves shall be installed vertically per the Drawings and with minimum depth of cover per Table 15111-1.

**Table 15111-1
Minimum Pipe Cover Required for Valves**

| Pipe Diameter (Inches) | Vertical Gate Valve Cover | |
|---|---------------------------|--------------------|
| | LOCAL Roadway | Non-LOCAL Roadway* |
| 4-inch – 8-inch | 30-inch | 36-inch |
| 12-inch | 36-inch | 36-inch |
| 16-inch | 44-inch | 48-inch |
| 20-inch | - | 50-inch |
| 24-inch | - | 54-inch |
| * Additional 12-inches of cover is required for all vertical valves 16-inches and greater located in the pavement | | |

- E. Valves 16-inches and larger shall be AWWA C515 resilient seated only (16-inches through 24-inches no gearing required).
- F. The valve body, bonnet, and bonnet cover shall be cast iron ASTM A126, Class B for C509 valves and ductile iron ASTM A536 for C515 valves. All ferrous surfaces inside and outside shall have a fusion-bonded epoxy coating in accordance with AWWA C 550.
- G. A 2-inch wrench nut shall be provided for operating the valve. Valves 30-inches and larger shall be provide with spur gear actuators. Side actuated gate valves are not acceptable. All valves shall open left or counter clockwise.
- H. The valves shall have non-rising stems with the stem made of cast, forged, or rolled bronze as specified in AWWA C509. Two (2) stem seals shall be provided and shall be of the O-ring type. The stem nut must be independent of the gate.

- I. The resilient sealing mechanism shall provide zero leakage at test and normal working pressure when installed with the flow from either direction.
- J. Tapping valves shall be placed vertical where possible for Water and Reclaimed Water. When tapping existing mains, valves 24-inches and above shall be furnished with NPT pipe plugs for flushing the tracks.
- K. All materials shall be in accordance with Appendix D "List of Approved Products."
- L. Provide (2) buried valve wrenches for 4-foot bury valves, (2) buried valve wrenches for 6-foot bury valves, (1) buried valve wrench with adjustable length.

PART 3 - EXECUTION

3.01 PREPARATION

- A. All valves shall be inspected upon delivery in the field to insure proper working order before installation. Valves shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connection ends furnished. All buried gate valves shall be connected using restrained joints. All valves and appurtenances shall be installed true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the County before installation.

3.02 INSTALLATION

- A. Install valves and accessories in strict accordance with manufacturer's instruction and recommendations as shown on the Drawings and as directed by the County.
- B. Carefully erect all valves and support them in their respective positions free from distortion and strain.
- C. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.
- D. Support all valves connected to pumps and equipment and in piping systems that cannot support valves.
- E. Repair any scratches, marks and other types of surface damage with original coating as supplied by the factory.
- F. Valves shall be carefully inspected, opened wide and then tightly closed and the nuts and bolts shall be tested for tightness. Special care shall be taken to prevent any foreign matter from becoming lodged in the valve seat. Any valve that does not operate correctly shall be removed and replaced.

3.03 INSPECTION AND TESTING

- A. Check and adjust all valves and accessories for smooth operation.

- B. Test valves for leakage at the same time that connecting pipelines are tested. See Section 02660 "Potable Water Distribution Piping" for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrument systems whose pressure rating is less than the pressure tests.

END OF SECTION

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**SECTION 15140
HVAC AND PLUMBING SUPPORTS AND ANCHORS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Pipe, duct, and equipment hangers, supports, and associated anchors.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.02 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish hanger and support inserts sleeves to Section for placement into formwork

1.03 SUBMITTALS

- A. Submit shop drawings and product data for all items listed under this section.
- B. Indicate hanger and support framing and attachment methods.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 2 to 4 inches: Stainless steel, adjustable, clevis.
- B. Multiple or Trapeze Hangers: Stainless steel channels with welded spacers and hanger rods; Stainless steel roll and stand for hot pipe sizes 6 inches and over.
- C. Wall Support for Pipe Sizes to 3 Inches: Stainless steel hook.
- D. Wall Support for Pipe Sizes 4 Inches and Over: Welded stainless steel bracket and clamp; adjustable stainless steel yoke and roll for hot pipe sizes 6 inches and over.
- E. Vertical Support: Stainless steel riser clamp.
- F. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe

- G. Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.
- H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- I. Shield for Insulated Piping 2 Inches and Smaller: 18 gage galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long per pipe support.
- J. Shield for Insulated Piping 2-1/2 Inches and Larger (Except Cold Water Piping): Pipe covering protective saddles.
- K. Shields for Insulated Cold Water Piping 2-1/2 Inches and Larger: Hard block non-conducting saddles in 90 degree segments, 12 inch minimum length, block thickness same as insulation thickness.
- L. Shields for Vertical Copper Pipe Risers: Sheet lead.

2.02 HANGER RODS

- A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.03 FLASHING

- A. Metal Flashing: galvanized steel.
- B. Lead Flashing: 5 lb/sq ft sheet lead for waterproofing; one lb/sq ft sheet lead for soundproofing.
- C. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.04 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: Form with 18 gage galvanized steel; plastic inserts or Schedule 40 steel.
- B. Sleeves for Pipes Through Non-fire Rated Walls, Footings, and Potentially Wet Floors: Form with steel pipe or 18 gage galvanized steel.
- C. Sleeves through beams shall be Schedule 40 steel; only in locations approved by the Structural Engineer.
- D. Sleeves for Round Ductwork: Form with galvanized steel.
- E. Flanges shall be 20 gage galvanized steel.

2.05 FABRICATION

- A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- B. Design hangers without disengagement of supported pipe.

2.06 FINISH

- A. Prime coat steel hangers and supports.

PART 3 - EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

| PIPE SIZE | MAX. HANGER SPACING | HANGER DIAMETER |
|-------------------------------------|------------------------|-----------------|
| 1/2 to 1-1/4 inch | 6'-6" | 3/8" |
| 1-1/2 to 2 inch | 10'-0" | 3/8" |
| 2-1/2 to 3 inch | 10'-0" | 1/2" |
| 4 to 6 inch | 10'-0" | 5/8" |
| PVC (All Sizes) | 6'-0" | 3/8" |
| C.I. Bell and Spigot (or No-Hub) | 5'-0" and at joints | 5/8" |

- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place a hanger within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. All hangers, hanger rods, supports, etc. shall be double nutted.

3.02 EQUIPMENT BASES AND SUPPORTS

- A. Provide equipment bases of concrete type.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct support of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.03 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and calk, metal counterflash and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, and mop sink drains watertight to adjacent materials.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

3.04 SLEEVES

- A. Extend sleeves through floors one inch above finished floor level. Calk sleeves full depth and provide floor plate.
- B. Install chrome plated steel escutcheons at finished surfaces.

END OF SECTION

**SECTION 15150
HVAC VIBRATION ISOLATION**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Supply necessary equipment such as inertia bases, vibration isolators, etc. as required to prevent excessive noise and vibration to be transmitted to the building from all motor driven equipment.

1.02 SUBMITTALS

- A. Submit shop drawings and product data for all materials listed under this section.
- B. Indicate inertia bases on shop drawings.
- C. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
- D. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATION EQUIPMENT AND METHODS

- A. Equipment vendors shall furnish the required isolation equipment and installation instructions with each piece of equipment.

PART 3 - EXECUTION

3.01 VIBRATION ISOLATORS

- A. Install vibration isolators for motor driven equipment.
- B. Color code spring mounts.
- C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support. Static deflection of first point shall be twice deflection of isolated equipment.

3.02 EQUIPMENT BASES

- A. Set steel bases for one inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.

3.03 ACCEPTANCE

- A. The Contractor shall be responsible to take the necessary steps to insure that no equipment operates with excessive noise or vibration transmission.

END OF SECTION

**SECTION 15200
HVAC GENERAL PROVISIONS**

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.

1.02 SCOPE OF WORK

- A. The Work shall include the furnishings of systems, equipment, and materials specified in this Division and as required by Contract Documents to include: supervision, operation, methods, and labor for the fabrication, installation, start-up, and tests for the complete mechanical installation.
- B. Drawings for the Work are diagrammatic, intended to convey the scope of the Work and to indicate the general arrangement and locations of the Work. Because of the scale of the Drawings, certain basic items such as pipe fittings, access panels, and sleeves may not be shown. This Contractor shall be responsible for selecting the equipment to fit the space provided. The location and sizes for ductwork, pipe fittings, sleeves, inserts, and other basic items required by code and other sections shall be coordinated and included for the proper installation of the work.
- C. Equipment Specification may not deal individually with minute items required such as components, parts, controls, and devices which may be required to produce the equipment performance specified or as required to meet the equipment warranties. Where such items are required, they shall be included by the supplier of the equipment, whether or not specifically called for in the Contract Documents.
- D. Where the words "provide", "furnish", "include", or "install" are used in the Specification or on the Drawings, it shall mean to furnish, install, and test complete and ready for operation, the items mentioned. If an item is indicated in the Contract Documents, it shall be considered sufficient for including same in the work.
- E. Where noted on the Drawings or where called for in other Sections of the Project Manual, the Contractor for this Division shall install equipment furnished by Others, and shall make required service connections. Contractor shall verify with the supplier of the equipment the requirements for the installation.
- F. Coordinate with all trades in submittal of shop drawings. Shop drawings shall be prepared clearly indicating all applicable components. Space conditions shall be detailed to the satisfaction of all concerned trades, subject to review and final acceptance by the

Engineer. In the event that the Contractor installs his work before coordinating with other trades or so as to cause any interference with work of other trades, the necessary changes shall be made in the work to correct the condition, at no additional cost to the Owner.

1.03 CODES AND STANDARDS

- A. Conform to latest edition of governing codes, ordinances, or regulations of city, county, state, or utility company having jurisdiction. Where local codes are not applicable, conform to Standard Plumbing Code; Standard Mechanical Code; Rules of Department of Air and Water Pollution Control; and National Electrical Code.
- B. Work not regulated by Governmental Bodies shall be performed in accordance with current issues of the following Codes and Standards.
 - 1. Air Moving and Conditioning Association - AMCA
 - 2. American National Standards Institute - ANSI
 - 3. American Society of Mechanical Engineers - ASME
 - 4. American Society for Testing and Materials - ASTM
 - 5. American Water Works Association - AWWA
 - 6. Factory Mutual - FM
 - 7. Manufacturers Standardization Society of the Valve and Fittings Industry - MSS
 - 8. National Electrical Manufacturers Association - NEMA
 - 9. National Fire Protection Association, National Electrical Code - NEC
 - 10. National Fire Protection Association - NFPA
 - 11. Occupational Safety and Health Act of 1970, as amended - OSHA
 - 12. Sheet Metal and Air Conditioning Contractors National Association - SMACNA
 - 13. Underwriters' Laboratories - UL
 - 14. Local and State Plumbing Code
 - 15. Utility Company Regulations as pertains to services provided
 - 16. Other Codes and Standards as individually referred to in the Technical Sections of the Specification.

1.04 FEES, PERMITS, AND INSPECTIONS

- A. Secure all permits and pay all fees required in connection with the Work.
- B. Coordinate and provide such inspections as are required by the Authorities with jurisdiction over the site.

- C. Where applications are required for procuring of services to the building, prepare and file such application with the Utility Company. Furnish all information required in connection with the application in the form required by the Utility Company.

1.05 ACTIVE SERVICES

- A. Existing active services; water, gas, sewer, electric, when encountered, shall be protected against damage. Do not prevent or disturb operation of active services which are to remain. If active services are encountered which require relocation, make request to authorities with jurisdiction for determination of procedures. Where existing services are to be abandoned, they shall be terminated in conformance with requirements of the Utility or Municipality having jurisdiction.

1.06 SITE INSPECTION

- A. Contractor shall inspect the site to familiarize himself with conditions of the site which will affect his work and shall verify points of connection with utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
- B. Extra payment will not be allowed for changes in the Work required because of Contractor's failure to make this inspection.

1.07 OPENINGS, CUTTING, AND PATCHING

- A. Coordinate the placing of openings in the new structure as required for the installation of the Mechanical Work.
- B. When additional patching is required due to failure to inspect work; then provide the patching required to properly close the openings, including patch painting.
- C. When cutting and patching of the structure is made necessary due to failure to install piping, ducts, sleeves, or equipment on schedule, or due to failure to furnish, on schedule, the information required for the leaving of openings, then provide the cutting and patching as required, including patch painting.

1.08 WIRING FOR MECHANICAL EQUIPMENT

- A. Division 16 shall provide power services for motors and equipment furnished by this Contractor to include safety disconnect switches and final connections.
- B. Division 15 shall provide all motors, motor starters, and contactors for equipment furnished under this Division, except where they are an integral part of a motor control center which is provided under another Division.

- C. Provide internal wiring, alarm wiring including for fire protection and/or security, control wiring, and interlock wiring for equipment furnished, to include temperature control wiring.
- D. Coordinate with Division 16 all motors and other mechanical equipment which require electrical services. Provide schedule which shall include the exact location for rough-in, electrical load, size, and electrical characteristics for all services required.
- E. Where motors or equipment furnished require larger services or services of different electrical characteristics than those called for on the Electrical Drawings, provide material as required to fit the substitute equipment.
- F. Electrical work provided under Division 15 shall conform to the requirements of Division 16.

1.09 PROTECTION

- A. Special care shall be taken for the protection of equipment furnished. Equipment and material shall be completely protected from weather elements, painting, plaster, etc. until the project is completed. Damage from rust, paint, scratches, etc. shall be repaired as required to restore equipment to original condition.
- B. Where the installation or connection of equipment requires work in areas previously finished by other Contractors, the area shall be protected and not marred, soiled, or otherwise damaged during the course of such work. Contractor shall arrange with the other Contractors for repairing and refinishing of such areas which may be damaged.
- C. When welding is required inside building, provide one man for a fire watch. Fire watch shall require adequate protection of existing surfaces and observance of lower floors where penetrations exist.

1.10 SUBMITTALS

- A. General:
 - 1. Submit to Architect/Engineer shop drawings and product data required by the drawings and specifications.
 - 2. Contractor shall compile all data including but not limited to ductwork materials and construction details, manufacturers catalog and product data, controls wiring diagrams and material data, piping, insulation, water treatment, and test and balance.
 - 3. Submit a minimum of 7 copies of data; more if required by the Architect.
- B. Submittal Requirements

1. Prepare submittals compiled in a 3 ring, hard bound, loose leaf binder. The face of the binder shall be clearly marked with the project title and number, the name of the Owner, Architect, Engineer, General Contractor and this contractor.
2. The first page inside the binder shall provide an index, numerically indicating all sections applicable to this submittal.
3. Separate binders shall be provided for HVAC and plumbing trades.
4. Where multiple options are available from a manufacturer, clearly indicate those which are intended to be included with project submittal.
5. Provide plastic, see-through hard tab dividers for each section submitted. In the event an item appears on the drawings not specifically covered by the specifications, provide an additional numeric tab at the end of the index detailing the item and include the submittal data in the binder.
6. Submit only complete project submittals. Partial submittals or submittals not complying with the above requirements shall be returned to the contractor unmarked and rejected.
7. In the interest of project expediency the contractor may pre-submit long lead items for pre-approval. However, the contractor shall not be relieved of including the same data as required by submittal binder and shall be included therein.
8. The Contractor may turn in submittals without control drawings if they require a longer production time. All other items shall be included.
9. Provide a tab for items not included and include an explanation of why item is not included in the submittal and the expected submittal date.
10. Review shop drawings and product data prior to submission to Architect/Engineer.
11. Verify field measurements, field construction criteria, catalog numbers, and similar data.
12. Coordinate each submittal with work of the project and Contract Documents.
13. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved by Architect/Engineer's review of submittals, unless Architect/Engineer gives written acceptance of specific deviations.
14. Notify Architect/Engineer in writing of deviations from requirements of Contract Documents at time submittals are made.
15. A "deviation" shall be construed to mean a minor change to the sequence indicated on drawings or specification.
16. A "deviation" is not intended to allow substitutions or product options.

17. Do not begin work which requires submittals until submittals have been returned with Architect/Engineer's stamp and initials or signature indicating review and approval.
18. Shop Drawings and/or submittals requiring resubmission to the Architect/Engineer due to non-compliance with the Contract Documents and/or incompleteness shall be thoroughly reviewed by the Contractor prior to delivery to the Architect/Engineer for review. The Contractor shall ensure the completeness and compliance of the submittal materials and shall reimburse the Architect/Engineer at their standard hourly billing rates for review of submittals/shop drawings beyond the second submission.
19. Attention is directed to the fact that Architect/Engineer's review is only to check for general conformance with the design concept of the project and general compliance with Contract Documents. No responsibility is assumed by Architect/Engineer for correctness of dimensions, details, quantities, procedures shown on shop drawings or submittals.
20. Omission in shop drawings of any materials indicated in Contract Drawings, mentioned in Specifications, or required for proper execution and completion of Work, does not relieve the Contractor from responsibility for providing such materials.
21. Approval of a separate or specified item does not necessarily constitute approval of an assembly in which item functions.

1.11 OPERATING AND MAINTENANCE MANUALS:

A. General:

1. Provide three up-to-date copies of shop drawings, product data, and other information described in this Section for use in compiling operating and maintenance manuals.
2. Provide legible submittals made by permanent reproduction copy equipment from typewritten or typeset originals.
3. Pre-punch 8-1/2 inch x 11 inch sheets for standard three ring binders.
4. Submit larger sheets in rolled and protected packages.

B. Compilation:

1. The Contractor will receive shop drawings, brochures, materials lists, technical data of all types, warranties, guarantees, and other pertinent information and will assemble, catalog, and file information in loose-leaf, hardback three-ring binders.
2. Submittal Format: (Provide each of the following items, as applicable, for each required item or system. Requirements will vary, depending on the equipment. Refer to specific Specification section requirements.)
3. Item: (Use appropriate Section title.)

4. System Description: (Provide a detailed narrative description of each system, describing function, components, capacities, controls and other data specified, and including the following:
 - a. Number of.
 - b. Sizes.
 - c. Type of operation.
 - d. Detailed operating instructions, including start-up and shut-down of each system, with indications for position of all controls, as applicable.
5. Wiring Diagrams: (Complete wiring diagrams for internally wired components including controls.)
6. Operating Sequence: (Describe in detail.)
7. Manufacturers Data: (Provide catalog data sheets, specifications, nameplate data and parts list.)
8. Preventative Maintenance: (Provide manufacturer's detailed maintenance recommendations.)
9. Trouble Shooting: (Provide manufacturer's sequence for trouble-shooting procedures for operational problems.)
10. Extra Parts: (Provide a listing of extra stock parts furnished as part of the Contract.)
11. Warranties: (Provide specific manufacturer's warranty. List each component and control covered, with day and date warranty begins, date of expiration, and name, address and telephone number of person to contact regarding problems during warranty period.)

- C. Directory: (Provide names, addresses and telephone numbers of Contractor, its subcontractors, suppliers, installers and authorized service and parts suppliers. Format as follows:

Contractor:
Address:
Telephone No.:
Person to Contact:

Subcontractor:
Address:
Telephone No.:
Person to Contact:

Installer:
Address:
Telephone No.:
Person to Contact:

Manufacturer:
Address:
Telephone No.:
Person to Contact:

Local Service Representative:
Address:
Telephone No.:
Person to Contact:

1.12 RECORD DRAWINGS

A. Detailed Requirements for Record Drawings

1. During the progress of the work, the Contractor shall require the job superintendent for the plumbing, air conditioning, heating, ventilating, and fire protection subcontractors to record on their field sets of drawings the exact locations, as installed, of all conduits, pipes, and ducts whether concealed or exposed which were not installed exactly as shown on the contract drawings.
2. Upon completion of the work this data shall be recorded to scale, by a competent draftsman on sepia line prints or transparent paper of the contract drawings. Sepia will be furnished to the Contractor by the Architect/Engineer, but cost shall be borne by Contractor. Where changes are to be recorded, the sepia line prints shall

be erased before the changes are made. Where the work was installed exactly as shown on the contract drawings the sepia line prints shall not be disturbed other than being marked "As-Built". In showing the changes the same legend shall be used to identify piping, etc., as was used on the contract drawings. A separate set of drawings shall be prepared for plumbing, heating, air conditioning, and ventilating work unless two or more divisions are shown on the same sheets of the contract drawings, in which case the various subcontractors shall also show their changes on the same sheets. Each sheet shall bear the date and name of the subcontractor submitting the drawings.

3. The Contractor shall review the completed As-Built drawings and ascertain that all data furnished on the sepia drawings are accurate and truly represent the work as actually installed. Where plumbing, hot or chilled water pipes, inverts etc., are involved as part of the work, the Contractor shall furnish true elevations and locations, all properly referenced by using the original bench mark used for the institution or for this project. The sepia line prints including those unchanged and changed shall be submitted to the Architect/Engineer.
4. The Contractor shall submit as-built drawings to the Architect/Engineer for review.
5. The Engineer shall authorize the Contractor to produce and distribute the as-built drawings as follows:
 - a. One (1) blue line to the Engineer.
 - b. One (1) blue line to the Architect.
 - c. One (1) sepia to the Owner.

1.13 SUBSTITUTIONS AND PRODUCT OPTIONS:

- A. For products specified only by reference standard, select product meeting that standard, by any manufacturer.
- B. For products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with specifications.
- C. For products specified by naming several products or manufacturers and stating "or equivalent", "or equal", or "or Architect/Engineer approved equivalent", or similar wording, submit a request for proposed substitutions for any product or manufacturer which is not specifically named; for review and approval by the Engineer.
- D. For products specified by naming only one product and manufacturer, there may be an option of an Engineer approval of a product of equal or greater quality or size.

1.14 SUBMISSIONS:

- A. Contractor's Base Bid shall be per contract documents.

- B. Submit separate request for each substitution. Support each request with:
1. Complete data substantiating compliance of proposed substitution with requirements stated in contract documents:
 2. Product identification, including manufacturer's name and address.
 3. Manufacturer's literature; identify:
 - a. Product description.
 - b. Reference standards.
 - c. Performance and test data.
 - d. Name and address of similar projects on which product has been used, and date of each installation.
 4. Itemized comparison of the proposed substitution with product specified; list significant variations.
 5. Data relating to changes in construction schedule.
 6. Any effect of substitution on separate contracts.
 7. List of changes required in other work or products.
 8. Designation of availability of maintenance services, sources of replacement materials.
 9. Provide certification of product compatibility with adjacent materials.

C. Substitutions will not be considered for acceptance when:

1. They are indicated or implied on shop drawings or product data submittals without a formal request from Contractor.
2. Acceptance will require substantial revision of contract documents.
3. In judgement of Engineer, do not include adequate information necessary for a complete evaluation.
4. Substitute products shall not be ordered or installed without written acceptance of Engineer.
5. Architect/Engineer will determine acceptability of proposed substitutions.

1.15 PRIME (GENERAL) CONTRACTOR'S REPRESENTATION:

- A. In making formal request for substitution, Prime (General) Contractor represents that:
1. He has investigated proposed product and has determined that it is equivalent to or superior in all respects to that specified.
 2. He will provide same warranties or bonds for substitution as for product specified.

3. He will coordinate installation of accepted substitution into the work, and will make such changes as may be required for the work to be complete in all respects.
 4. He waives claims for additional costs caused by substitution which may subsequently become apparent.
- B. Cost data is complete and includes related costs under his contract, but not:
1. Costs under separate contracts.
 2. Architect/Engineer's costs for redesign or revision of contract documents.

1.16 ARCHITECT/ENGINEER DUTIES:

- A. Review Contractor's requests for substitutions with reasonable promptness.
- B. Notify Contractor in writing of decision to accept or reject requested substitution.

1.17 FINISHING

- A. General: Prior to acceptance of the installation and final payment of the Contract, the Contractor shall perform the work outlined herein.
- B. Cleaning: At the conclusion of the construction, the site and structure shall be cleaned thoroughly of all debris and unused materials remaining from the mechanical construction. All closed off spaces shall be cleaned of all packing boxes, wood frame members, and other waste materials used in the mechanical construction.
- C. The entire system of piping and equipment shall be cleaned internally. The Contractor shall open all dirt pockets and strainers, completely blowing down as required and clean strainer screens of all accumulated debris.
- D. All tanks, fixtures, and pumps shall be drained and proven free of sludge and accumulated matter.
- E. All temporary labels, stickers, etc., shall be removed from all fixtures and equipment. (Do not remove permanent name plates, equipment model numbers, ratings, etc.).
- F. Heating and air conditioning equipment, tanks, pumps, etc., shall be thoroughly cleaned and new filters or filter media installed.

1.18 TEST AND DEMONSTRATIONS

- A. Systems shall be tested and placed in proper working order prior to demonstrating systems to Owner.

- B. Prior to acceptance of the mechanical installation, demonstrate to the Owner or his designated representatives all essential features and functions of all systems installed, and instruct the Owner in the proper operation and maintenance of such systems. The contract shall allow for five (5) working days to perform the demonstrations.
- C. Provide necessary trained personnel to perform the demonstrations and instructions. Provide manufacturer's representatives for systems as required to assist with the demonstrations.
- D. Dates and times for performing the demonstrations shall be coordinated with the Owner.
- E. Upon completion of demonstrations, provide a certificate testifying that demonstrations have been completed. Certificate shall list each system demonstrated, dates demonstrations were performed, names of parties in attendance, and shall bear signatures of contractor and owner.

1.19 PAINTING AND IDENTIFICATION

- A. Provide painting as scheduled below:
 - 1. Touch-up paint where damaged on equipment furnished with factory applied finished, to match original finish.
- B. Identification of mechanical systems shall be as specified in Section 15190; MECHANICAL IDENTIFICATION.

1.20 EXCAVATING, TRENCHING, AND BACKFILLING

- A. Provide excavation necessary for underground water piping, etc., and backfill such trenches and excavations after work has been installed and tested. Care shall be taken in excavating, that walls and footings and adjacent load bearing soils are not disturbed, except where lines must cross under a wall footing. Where a line must pass under footing, the crossing shall be made by the smallest possible trench to accommodate the pipe. Excavation shall be kept free from water by pumping if necessary. No greater length of trench shall be left open, in advance of pipe and utility laying, than that which is authorized.
- B. Trenches for piping and utilities located inside foundation walls and to point five (5) feet outside of the wall shall be not less than sixteen (16) inches nor more than twenty-four (24) inches wider than the outside diameter of the pipe to be laid. The widths of trenches for piping and utilities located more than five (5) feet outside of building foundation walls, other than for sewers, shall be governed by conditions found at the site.
- C. Bottoms of trenches shall be so shaped that when pipe is in place the lower fourth of the circumference for the full length of the barrel will be supported on compacted fill. Bell holes shall be dug so that no part of the weight of the pipe is supported by the bell but

shall be no larger than necessary for proper jointing. All sewers and piping required for the structure shall be excavated to at least (6) inches below pipe invert.

- D. Immediately after testing and/or inspection, the trench shall be carefully backfilled with earth free from clods, brick, etc., to a depth one-half the pipe diameter and then firmly puddled and tamped in such a manner as not to disturb the alignment or joints of the pipe. Thereafter, the backfill shall be puddled and tamped every vertical foot.

1.21 CONCRETE WORK

- A. Provide concrete bases and housekeeping pads for mechanical equipment unless indicated otherwise. Concrete work shall be as specified in the applicable Civil/Site and Structural Sections. Vibration pads, equipment bases, pipe supports and thrust blocks shall be provided by this Contractor.
- B. Provide equipment anchor bolts and coordinate their proper installation and accurate location.

1.22 ACCESS PANELS

- A. Provide access panels where required and not shown on the drawings for installation by the drywall Contractor. Access panels shall be as specified in the applicable architectural section. All access panel locations which allow access to mechanical equipment shall be approved by the Architect/Engineer.

1.23 SLEEVES

- A. Sleeves passing through non-load bearing or non-fire rated walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows: for pipes 2-1/2" size and smaller - 24 gauge; 3" to 6" - 22 gauge.
- B. Sleeves passing through load bearing walls, concrete beams, foundations, footings, and waterproof floors shall be Schedule 40 galvanized steel pipe or cast iron pipe.
- C. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.
- D. In finished areas where pipes are exposed, sleeves shall be terminated flush with wall, partitions, and ceilings, and shall extend 1/2" above finished floors. Extend sleeves 1" above finished floors in areas likely to entrap water.
- E. Pipe to wall penetration closures for underground pipe penetrations of walls shall be "Link-Seal" as manufactured by Thunderline Corporation, or equal.

1.24 ESCUTCHEONS

- A. Provide chrome plated escutcheons at each sleeved opening into finished and exposed exterior spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

1.25 INSULATION PROTECTION

- A. Where exposed insulated piping extends to floor, provide sheet metal guard around insulation.

1.26 ANCHORING OF EQUIPMENT

- A. All equipment located on floor slab, that is not mounted on wheels and is capable of being moved shall be secured to the floor with anchor bolts. A minimum of two bolts are required per each piece of equipment and bolts shall be of sufficient size to prevent equipment from overturning.

1.27 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Water piping shall not be installed in electrical rooms or directly above electrical equipment.

1.28 CONNECTIONS FOR FIXTURES AND EQUIPMENT UNDER ANOTHER SECTION OR BY OWNER

- A. Rough all equipment requiring connection to systems provided under this Division. Verify requirements and current locations before proceeding with work.
- B. Make all connections to equipment furnished under another Section or by owner as required to obtain complete and working systems.

1.29 SYSTEM GUARANTEE:

- A. Work required under this Division shall include one-year guarantee. Guarantee by Contractor to Owner to replace for Owner any defective workmanship or material which has been furnished under contract at no cost to the Owner for a period of one year from date of acceptance of systems. Guarantee shall also include all reasonable adjustments of system required for proper operation during guarantee period. Guarantee shall not include normal preventative maintenance services or filters.

- B. At "Demonstration", one-year guarantee provision by Contractor shall be explained to Owner.
- C. All sealed hermetic refrigeration systems shall be provided with five-year factory warranty.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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**SECTION 15256
INSULATION FOR CONDENSATE DRAINS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work of this section shall include providing the thermal insulation for mechanical systems and shall include the following principal items:
 - 1. Condensate Drains
- B. This work shall be performed by competent workmen regularly engaged in the scope of work described herein.

1.02 SUBMITTALS

- A. Submittals and product literature for each insulation type, finish type and equipment served, shall be required. Provide submittals on method of installation for each type of insulation used.
- B. Product samples and installation samples are required and shall be provided at the discretion of the engineer.

PART 2 - PRODUCTS

2.01 THERMAL INSULATION

- A. All insulating systems shall be tested on a composite basis in accordance with NFPA and UL 723 and shall have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 under ASTM E-84.

2.02 INSULATION TYPES

- A. Closed cell, flexible elastomeric thermal insulation, black in color, supplied in unslit tubing. Equal to Armaflex AP 2000.
- B. Closed cell, elastomeric thermal insulation tape. Commonly supplied in 2" X 1/8" thick. Equal to Armaflex insulation tape.

2.03 ADHESIVES

- A. An air drying contact adhesive specifically designed for joining seams and ends of Armaflex AP-2000 in specification section 2.02-A. Comply with Mil Spec. Mil-A-24179A and Amend-2 as type 11, class 1. Equal to Armstrong 520 adhesive.

2.04 FINISHES

- A. A white, elastomeric, UL classified outdoor grade, vinyl mastic for finished outdoor insulation. Water based latex enamel. Equal to WB Armaflex finish.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. All materials shall be applied by Workmen skilled in this trade. Unsightly work shall be cause for rejection.
- B. Mechanical fasteners shall be used whenever possible to assure permanent construction.
- C. Materials shall be applied only after systems have been tested and all surfaces are clean and dry.
- D. Cellular glass block supports or other suitable non-compressible insulation material equal in thickness to the insulation and three times the pipe diameter in length shall be installed at hangers to eliminate through-metal conductance. Provide 18 GA, 180 degree, galvanized sheet metal saddles same length as block supports.
- E. All insulation of cold surfaces shall be vapor sealed. All joints, laps, breaks and faults in vapor barriers of insulations covering cold surfaces shall be thoroughly sealed.
- F. Insulation that becomes wet for any reason shall be removed, replaced and resealed at the expense of this Contractor.
- G. Piping systems requiring tests to be witnessed by the Architect shall not be insulated until such systems have been tested and approved.

3.02 APPLICATION

- A. Insulation shall be butted together and adhered in place with joint adhesive (see Part 2, 2.03, A). All joints and seams shall be sealed with contact adhesive. Where possible insulation shall be slipped on without slitting. Insulation shall be butted firmly to equipment. Short radius elbows shall be mitered, adhesive applied and firmly held together until the adhesive hardens sufficiently to prevent separation.

- B. Provide removable sections of insulation at all clean outs.
- C. Paint all exposed insulation with Armaflex white paint (see Part 2, 2.04, A).
- D. Provide sheet metal saddles for all insulated condensate piping at pipe supports.

3.03 INSULATION THICKNESS

- A. Provide 1/2" thick insulation materials for all condensate piping.

3.04 MISCELLANEOUS

- A. This contractor will contact the engineer at the start of all phases of work, as follows:
 - 1. During installation of any concealed insulation.
 - 2. During installation of above ceiling insulation work.
- B. The engineer will ascertain the continuation of work subject to the requirements aforementioned.

END OF SECTION

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**SECTION 15258
DUCTWORK INSULATION**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work of this section shall include providing the thermal insulation for mechanical systems and shall include the following principal items:
 - 1. Supply, Return, Outside, and Relief Air ductwork concealed.
 - 2. Supply, Return, Outside, and Relief Air ductwork exposed.
 - 3. Supply, Return, Outside, and Relief Air ductwork concealed outside of building insulation envelope (attic/crawlspace).
 - 4. Exhaust Air ductwork concealed.
 - 5. Exhaust Air ductwork exposed.
 - 6. Lined ductwork.
- B. Not all of the insulation types specified herein may be required on this project. The contractor is only to provide those insulation types required for the applications on this project.
- C. This work shall be performed by a competent insulation contractor regularly engaged in the scope of work described herein.

1.02 SUBMITTALS

- A. Submittals and product literature for each insulation type, finish type, and equipment served. Provide submittals on method of installation for each type of insulation used.

PART 2 - PRODUCTS

2.01 THERMAL INSULATION

- A. All insulating systems shall be tested on a composite basis in accordance with NFPA and UL 723 and shall have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 under ASTM E-84.
- B. Insulation Types:
 - 1. FIBERGLASS BLANKET

- a. Made of flame - attenuated glass fibers, bonded with a thermosetting resin. Reinforced with fiberglass scrim facing laminated to UL rated kraft. FSK facing, .02 perms, .00035" foil thickness per ASTM E-96, procedure A. 2" thick, 0.75 PCF, 7.1 R value. Equal to Manville, MicroLite.

2. RIGID FIBERGLASS

- a. 3 lb. density, .23 k factor. Mil spec HH-1-558B.. Inorganic glass fibers bonded by a thermosetting resin with an FSK jacket in compliance with NFPA 90A AND 90B standards. Equal to Manville 814, 3 lb density, 2" thick with FSK jacket.

3. FIBERGLASS BLANKET

- a. Made of flame - attenuated glass fibers, bonded with a thermosetting resin. Reinforced with fiberglass scrim facing laminated to UL rated kraft. FSK facing, .02 perms, .00035" foil thickness per ASTM E-96, procedure A. 3" thick, 3/4 lb., 10.7 R value. Equal to Manville, Microlite.

4. SEMI RIGID FIBERGLASS BOARD

- a. 3lb. density, thermal conductivity compliance ASTM C 518, 650 degrees F temperature limit, 1 1/2" thick. High temperature fiberglass bonded to a flexible jacketing. Jacketing is a laminate of white kraft and aluminum foil, reinforced with fiberglass, chemically treated for fire and smoke safety. Equal to Manville Pipe and Tank Insulation.

5. DUCT LINER

- a. Acoustical and thermal insulation manufactured from long textile, type glass fibers firmly bonded together with a thermosetting resin. Air stream surface is coated to protect against air erosion. Up to 250 degrees F (ASTM C 411), NFPA 90A and 90B, ASTM C 1071: not greater than 0.5% moisture by volume at 120 degrees F and 96% RH. Equal to Certainteed 1" thick, type 150, .28 K value for up to 2,500 FPM velocity.

6. DUCT LINER

- a. Same as number 5 except type 300, 1" thick, .24 K factor, up to 6000 FPM.

C. Weather Barrier Mastics

- 1. An emulsion type material compounded of selected and processed bitumens and mineral fillers. Equal to INSULKOTE ET. and INSULKOTE PRIMER E.

D. Duct Tape

1. FSK, glass fiber impregnated with foil facing, 4"wide, M.L spec HHB100, 25/50, ASTM E-84.
- E. Adhesives
1. Water based adhesives for attaching low density fibrous insulation and duct liner to metal. Service temperature limits-20 degrees F to 250 degrees F, UL MJAT-2, ASTM C 916, type 11, NFDA 90A and 90B. Equal to Foster Quick Tack Adhesive 85-60.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. All materials shall be applied by Workmen skilled in this trade. Unsightly work shall be cause for rejection.
- B. Mechanical fasteners shall be used whenever possible to assure permanent construction.
- C. Materials shall be applied only after systems have been tested and all surfaces are clean and dry.
- D. All insulation of cold surfaces shall be vapor sealed. All joints, laps, breaks and faults in vapor barriers of insulations covering cold surfaces shall be thoroughly sealed.
- E. Insulation that becomes wet for any reason shall be removed, replaced and resealed at the expense of this Contractor.

3.02 APPLICATION

- A. Interior, Concealed Square or Round Ductwork
 1. Use FIBERGLASS BLANKET as per Part 2, 2.01, B-1. For square ducts with any one dimension not greater than 24". Insulation shall be wrapped around ducts and secured with outward clinching staples at 4 inches o.c.. Ducts 24 inches and greater shall have insulation additionally secured with stick clips on 18 inch centers or with 4 inch wide bands of adhesive applied on 18 inch centers. Insulation shall be lapped a minimum of 4" and all seams and penetrations shall be sealed with FSK Duct tape as per Part 2, 2.01, D-1.
- B. Rectangle, Interior Supply, Return, Outside Relief and Exhaust Air Ductwork, Exposed.
 1. Use FIBERGLASS BOARD insulation as per Part 2, 2.01, B-2, and shall be applied to ducts with mechanical fasteners such as stick cups or weld pins at 12 inch centers. Install fiberglass board in full pieces. Joints and seams shall be covered with 4" tape as per Part 2, 2.01, D-1. Where standing seams or angle supports exceed insulation thickness an additional layer of board will be used.

- C. Round, Interior Supply, Return, Outside , Exhaust and Relief Ductwork Exposed.
1. Round ductwork use SEMI RIGID FIBERGLASS BOARD as per Part 2, 2.01, B-4. Flexible fiberboard shall be applied to ducts with outward clinching staples. Make any fabrication cuts to accommodate the proper fitting of the insulation before stapling. In addition any square ducts with a width of 24" or greater shall employ the use of stick clips spaced at 12" o.c.. Joints, seams and any penetrations shall be sealed with matching tape.
- D. Supply, Return, Outside, Relief or Exhaust Ductwork Outside of Building Insulation
1. Use FLEXIBLE FIBERGLASS INSULATION as per Part 2, 2.01, B-3. Ductwork shall be wrapped and secured with outward clinching staples at 4 inches o.c.. Ducts 24" and wider shall have the insulation additionally secured with stick on clips on 18" centers. Insulation shall be lapped 4" and all seams and penetrations shall be vapor sealed with FSK tape (Part 2, 2.01, D-1).
- E. Supply, Return, Outside, Relief and Exhaust Ductwork Indicated on the Plans to be Lined.
1. Use DUCT LINER (Part 2, 2.01, C-5), (Part 2, 2.01, B-5 or B-6), and (Part 2, 2.01, E-1). Liner shall be attached to metal using adhesive covering 90% of the metal. All edges of liner facing the direction of airflow and not receiving metal nosing shall be coated with adhesive. Liner shall be neatly butted without gaps at transverse joints and shall be coated with adhesive at such joints.
 2. Liner shall be folded and compressed in the corners of rectangular duct sections or shall be cut and fit to assure butted edge overlapping. Longitudinal joints in duct liner shall not occur except at the corners of ducts unless the size of the duct and standard liner product dimensions make such necessary.
 3. Interior widths of duct not exceeding 8" do not require mechanical fasteners in addition to adhesive.
 4. Interior widths of duct exceeding 8" will require mechanical fasteners as follows:

| <u>Velocity</u> | <u>Transversely Around Perimeter</u> | <u>Longitudinally</u> |
|----------------------------|--|--|
| 2500 fpm dn | At 4" from corners and at intervals not exceeding 12" | At 3" from transverse joints and at intervals not exceeding 18" |
| 2501 fpm to 6000 fpm | At 3"from corners and at intervals not exceeding 6" | At 3" from transverse joints and at intervals not exceeding 16" |

5. Mechanical fasteners will be applied with an approved mechanical fastening system. Hand driven pins with hammers will not be approved. Weld pins or "Grip Nails" or equal.
6. Longitudinal joints in liner shall be coated with adhesive at velocities over 2500 fpm.
7. Metal nosing that are either channel or zee profile or are integrally-formed from the duct wall shall be securely installed over transversely oriented liner edges facing the airstream at fan discharge and at any interval of lined duct preceded by unlined duct. In addition, where velocities exceed 4000 fpm metal nosing shall be used on upstream edges of liner at every transverse joint.
8. Where dampers, turning vane assemblies or other devices are placed inside of lined duct or fittings, the installation must not damage the liner or cause erosion of the liner. The use of metal hat sections or other buildout means is optional; when used, buildouts shall be secured to the duct wall with bolts, screws, rivets or welds.
9. Ductwork indicated to be lined shall be lined accordingly:
 - a. Up to 2,500 FPM velocity (Part 2, 2.01, B-5)
 - b. 2,500 FPM to 6,000 FPM velocity (Part 2, 2.01, B-6)

3.03 MISCELLANEOUS

- A. Ductwork indicated on the drawings to be internally lined shall not be insulated externally.
- B. All insulating systems described herein shall conform to the latest edition of SMACNA and will comply with NFPA-90A, 90B, 30; TIMA AHC-101; ASTM C390, C167, C553, E84, C177, C423, C411, C916, D903, D93, D1151; ASHRAE; ACGIH; Tested for UL 181; Mil Spec A 3316B

- C. The engineer will reserve the right to accept or reject any and all work not in compliance with the aforementioned. The engineer will be contacted for inspection during any of the following operations:
1. During installation of any ductwork wrapping.
 2. During the installation of ductwork that has been lined.

END OF SECTION

**SECTION 15268
INSULATION FOR REFRIGERANT PIPING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Work of this section shall include providing the thermal insulation for mechanical systems and shall include the following principal items:

Refrigerant Suction Line

- B. This work shall be performed by competent workmen regularly engaged in the scope of work described herein.

1.02 SUBMITTALS

- A. Submittals and product literature for each insulation type, finish type and equipment served, shall be required. Provide submittals on method of installation for each type of insulation used.

- B. Product samples and installation samples are required and shall be provided at the discretion of the engineer.

PART 2 - PRODUCTS

2.01 THERMAL INSULATION

- A. All insulating systems shall be tested on a composite basis in accordance with NFPA and UL 723 and shall have a maximum flame spread rating of 25 and a maximum smoke developed rating of 50 under ASTM E-84.

2.02 INSULATION TYPES

- A. Closed cell, flexible elastomeric thermal insulation, black in color, supplied in unslit tubing. Equal to Armaflex AP 2000.

- B. Closed cell, elastomeric thermal insulation tape. Commonly supplied in 2" X 1/8" thick. Equal to Armaflex insulation tape.

2.03 ADHESIVES

- A. An air drying contact adhesive specifically designed for joining seams and ends of Armaflex AP-2000 in specification section 2.02-A. Comply with Mil Spec. Mil-A-24179A and Amend-2 as type 11, class 1. Equal to Armstrong 520 adhesive.

2.04 FINISHES

- A. A white, elastomeric, UL classified outdoor grade, vinyl mastic for finished outdoor insulation. Water based latex enamel. Equal to WB Armaflex finish.
- B. Install field applied aluminum-foil-face jacket over all piping interior/exterior. Aluminum jacket shall comply with ASTM B 209. Factory-fabricated fitting covers. Equal to Childers Products Metal Jacketing Systems.

PART 3 - EXECUTION

3.01 WORKMANSHIP

- A. All materials shall be applied by Workmen skilled in this trade. Unsightly work shall be cause for rejection.
- B. Mechanical fasteners shall be used whenever possible to assure permanent construction.
- C. Materials shall be applied only after systems have been tested and all surfaces are clean and dry.
- D. Cellular glass block supports or other suitable non-compressible insulation material equal in thickness to the insulation and three times the pipe diameter in length shall be installed at hangers to eliminate through-metal conductance. Provide 18 GA, 180 degree, galvanized sheet metal saddles same length as block supports.
- E. All insulation of cold surfaces shall be vapor sealed. All joints, laps, breaks and faults in vapor barriers of insulations covering cold surfaces shall be thoroughly sealed.
- F. Insulation that becomes wet for any reason shall be removed, replaced and resealed at the expense of this Contractor.
- G. Piping systems requiring tests to be witnessed by the Architect shall not be insulated until such systems have been tested and approved.

3.02 APPLICATION

- A. Insulation shall be butted together and adhered in place with joint adhesive (see Part 2, 2.03, A). All joints and seams shall be sealed with contact adhesive. Where possible

insulation shall be slipped on without slitting. Insulation shall be butted firmly to equipment. Short radius elbows shall be mitered, adhesive applied and firmly held together until the adhesive hardens sufficiently to prevent separation.

- B. Paint all exposed insulation with Armaflex white paint (see Part 2, 2.04, A).
- C. Provide sheet metal saddles for all insulated refrigerant piping at pipe supports.

3.03 INSULATION THICKNESS

- A. Provide 3/4" thick insulation materials for all refrigerant suction line piping.

3.04 MISCELLANEOUS

- A. This contractor will contact the engineer at the start of all phases of work, as follows:
 - 1. During installation of any concealed insulation.
 - 2. During installation of above ceiling insulation work.
- B. The engineer will ascertain the continuation of work subject to the requirements aforementioned.

END OF SECTION

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SECTION 15504
REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide refrigerant piping systems complete with all accessories as specified herein and/or as indicated on the Drawings.
- B. Pressure test all refrigerant piping systems as specified herein.

1.02 REFERENCES

- A. American National Standards Institute (ANSI)
- B. American Society of Mechanical Engineers (ASME)
- C. American Society of Testing and Materials (ASTM)

1.03 SUBMITTALS

- A. Submit manufacturer's catalog data for all materials and equipment listed under this section.

PART 2 - PRODUCTS

2.01 PIPING

- A. Refrigerant Piping shall be copper ACR tubing Type L hard drawn or Type K per ASTM B280 and shall be cleaned, dehydrated, charged with gaseous nitrogen and sealed. Fittings shall be forged or wrought copper. Joints shall be brazed silver.
- B. Condensate Drain Piping pipe shall be Type M hard drawn per ASTM B88. Fittings shall be wrought copper or cast brass. Joints shall be lead free, tin-silver solder.

2.02 FILTER DRIERS

- A. Filter/dryers in sizes 1/2" and larger shall be the full-flow, replaceable-core type. Sizes smaller than 1/2" shall be the sealed type. Cores shall be of a suitable desiccant that will not plug, cake, dust, channel, or break down but shall remove water, acid, and foreign material from the refrigerant. The dryer shall be constructed so that no desiccant will pass into the refrigerant lines. A filter/dryer shall be provided in the liquid line to each

evaporator and shall be piped with two isolation valves. Pressure drop through the dryer shall not exceed 2 psi when operating at full connected evaporator capacity.

- B. Liquid Sight Glasses. Sight glasses shall be double glass, see-through type, with cover cap on each side. Sight glass shall be provided in liquid line immediately preceding each expansion valve. Glass shall be furnished with a color-change-type moisture indicator.
- C. Moisture Indicators. Color-change moisture indicators shall be provided downstream from each filter/dryer and bypass or shall be combined as a single unit in the liquid sight glasses.
- D. Shutoff Valves. Shutoff valves shall be packless diaphragm (in sizes commercially available), with packed, ground-finish stem, key operated, back seating, sealed-cap type; otherwise, angle pattern valves shall be used whenever possible.
- E. Solenoid Valves. Valves shall be brass or steel body, packless type, with corrosion-resistant steel trim, rated for continuous-duty service, direct-or pilot-operated, provided with manual lift stems, and designed for use with type of refrigerant used. The valve capacities shall be sufficient for the requirements of the installation at a pressure drop not in excess of 2 psi. Valves in suction lines shall be sized in accordance with temperature rise and superheat normal to the system.
- F. Expansion Valves. Shall be thermal-expansion type to suit specific system refrigerant, designed to fit coil distributors, and capable of operating from 40 to 100 percent of full load at system head pressure without hunting or liquid hammer. Valves shall have external equalizer connections and external superheat adjustments with seal caps. Joint connections shall be mechanical threaded or flanged type. Valves shall require not over 4 degrees F. superheat change to move from fully open to fully closed position. Superheat setting shall be 10 degrees F. at full load. Expansion valves shall be balanced double seated or pilot operated, capable of stable operation at 15 percent design load. Each valve shall be provided with external strainer.

PART 3 - EXECUTION

3.01 GENERAL

- A. Piping shall be accurately cut to measurements established at the project site, worked into place without springing or forcing, run as directly as possible, run parallel or perpendicular to building lines, located as indicated on the Drawings and supported as specified elsewhere. Parallel piping shall be grouped together as much as practical. Piping shall be supported as high as practical. Piping not located in mechanical rooms shall be concealed unless noted otherwise.

- B. Piping shall be run as directly as possible, avoiding all unnecessary fittings and joints. Changes in routing of piping due to field conditions shall be at the expense of this Contractor.
- C. Provide sleeves for all piping penetrations of floors and walls. Sleeves for insulated piping above grade shall be sized for the insulation diameter.
- D. Provide escutcheon plates at each exposed piping penetration of walls and ceilings. Escutcheon plates for insulated piping shall be sized for the insulation diameter.

3.02 REFRIGERANT PIPING SYSTEMS

- A. Provide a complete refrigerant tubing system as indicated on the Drawings.
- B. All refrigerant piping shall be ACR Type L hard drawn tubing except for exposed piping in public areas which shall be ACR Type K tubing.
- C. Unless otherwise noted on the Drawings, all refrigerant lines shall be sized in accordance with the equipment manufacturer's recommendations.
- D. All elbows in refrigerant piping systems shall be long radius elbows.
- E. Joints shall be silver brazed using a continuous flow of nitrogen inside the piping to prevent oxidation.
- F. All piping shall be rigidly supported.
- G. Provide filter driers, sight glasses, moisture indicators, shutoff valves, solenoid valves and expansion valves when not provided as standard or as an option on equipment. Components shall be specifically designed for refrigeration service.
- H. Pressure test each piping system at 150 psig using dry nitrogen. Test each joint for leaks by spraying with soapy water. Joints that leak shall be disassembled, cleaned to bare copper and silver brazed again. Pressure test shall be repeated until all joints pass.
- I. Vacuum test each piping system after pressure test is completed. Piping shall be drawn to 500 microns of HG and tested for 12 hours without additional pumping. If piping system fails vacuum test repeat pressure test.
- J. Charge each piping system after vacuum test is completed. Charge each system per manufacturer's instructions. Halide torch test each joint after charging.

3.03 CONDENSATE DRAIN PIPING

- A. Provide condensate drain trap of sufficient depth to allow proper drainage of condensate.
- B. Slope piping at a uniform slope of at least 1/8" per foot to ensure proper drainage.

- C. Condensate drain lines shall be adequately supported to prevent low points which would cause "Double Trapping".
- D. Condensate drain lines indicated to be terminated at floor drains shall either be turned down through this floor drain grate or be provided an indirect waste funnel for the floor drain.

END OF SECTION

SECTION 15682
AIR COOLED SPLIT SYSTEM CONDENSING UNITS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work of this section consists of providing all material, labor and equipment necessary for the fabrication and installation of all equipment and appurtenances specified herein and as indicated on the drawings.
 - 1. 2 - 5 ton 3 phase units.
- B. Not all the equipment specified herein may be used on this project. Refer to schedules on drawings for equipment requirements.
- C. All compressors shall have 5 year warranty.

1.02 SUBMITTALS

- A. Submit catalog data, shop drawings and installation instructions prior to commencement of work for all materials and equipment incorporated into the drawings and specified herein.

PART 2 - PRODUCTS

2.01 2 - 5 TONS SPLIT SYSTEM CONDENSING UNITS

- A. Units shall be UL listed, CSA certified and rated in accordance with A.R.I.
- B. Condenser coils shall be internally finned or smooth bore 3/8 inch copper tubing mechanically bonded to configured aluminum plate fin. Coils shall be factory pressure tested.
- C. Condensing units shall be completely factory wired and tested, control wiring shall be 24 volt. Provide head pressure control for operation to 0 degrees F. Provide anti-short cycle timer to prevent rapid on-off compressor cycling. Provide condenser coil guards, crankcase heaters, temperature and current sensing motor overloads, electronic defrost system, outdoor temperature sensor and switchover valve.
- D. Units shall be TRANE 4TTA series or equals by Carrier and Lennox.

PART 3 - EXECUTION

3.01 GENERAL

- A. All equipment shall be installed in accordance with the recommendations of the manufacturer.
- B. Refrigerant line sizes may differ from what is indicated on the prints with different manufacturers. This contractor is responsible for any changes or accessories required due to the specific requirements of a particular manufacturer. All refrigerant lines shall be sized by the manufacturer and approved by the engineer prior to any work commencement.
- C. Provide and install any accessories necessary for a complete and functioning system.
- D. All condensers shall be set on 6" thick concrete slabs for on grade installations.

END OF SECTION

**SECTION 15731
AIR HANDLING UNITS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. The work of this section consists of providing all labor, materials and services necessary for the fabrication and installation of all equipment and appurtenances specified herein and indicated on the drawings.
- B. Not all items in this section may be used. Refer to the related equipment schedule for relative information to this section.

1.02 SUBMITTALS

- A. Submit catalog data, shop drawings and installation instructions prior to commencement of work for all materials and equipment incorporated into the drawings and specified herein.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. Provide air handling units of the type, configuration and capacity as specified herein and as indicated on the drawings. Units shall be complete with fans, motors, safety devices, wiring terminals, fan relays and control transformers. Units shall be provided with all accessories required to permit the mounting configuration indicated on the drawings. Units shall be UL listed.
- B. Cabinets shall be constructed of cold-rolled steel with baked enamel finish. Cabinets shall be provided with factory installed internal insulation as required to eliminate condensation, full size access panels for access to all internal components, supply and return duct connection flanges, filter racks and filters.
- C. Direct drive fans shall be backward curved, plenum type and be statically and dynamically balanced. Fans shall be mounted on motor shafts. Motors shall be factory lubricated, resiliently mounted, multi-speed, permanent split capacitor type with internal overload protection. Fan-motor assembly shall slide out for service.
- D. Belt driven fans shall be backward curved, plenum type and be statically and dynamically balanced with adjustable belt drive. Thermal overload protection shall be standard on motors. Fans and motor bearings shall be permanently lubricated.

E. Units Equipped with DX Coils

1. DX Coils shall be constructed of aluminum fins mechanically bonded to nonferrous tubing. All joints shall be brazed. Coils shall be provided with a properly sized refrigerant metering device. Metering device shall be manufacturer's standard device unless indicated otherwise. Coils shall be provided with refrigerant line fittings to permit mechanical connections. Coils shall be provided with condensate drain pans with primary and auxiliary drain connections.
2. Equal to Trane, Carrier, Lennox.

PART 3 - EXECUTION

3.01 GENERAL

- A. All equipment shall be installed in accordance with the manufacturer installation instructions.
- B. Provide thermal expansion valves on DX coils.
- C. Provide vibration isolators for air handling units see specifications and drawings for types, quantities, etc.
- D. Provide any accessories necessary for a complete and functioning system.
- E. For air handling units above ceiling provide drain pans under the complete unit with auxiliary drain. Pipe drain to a conspicuous area, as indicated on the drawings.

END OF SECTION

**SECTION 15754
CENTRIFUGAL IN LINE CABINET VENTILATORS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide ventilating systems as indicated on the drawings and as specified herein with all accessories required for proper system balance.

1.02 REFERENCES

- A. Air Diffusion Council (ADC)
- B. Air Movement and Control Association (AMCA)
- C. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- D. National Fire Protection Association (NFPA)
- E. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- F. Underwriter's Laboratories, Inc. (UL)

1.03 SUBMITTALS

- A. Submit catalog data and shop drawings for all materials and equipment listed under this section.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL IN LINE CABINET VENTILATORS

- A. Inline Centrifugal Fans shall be UL listed and bear the AMCA Seal for air and sound performance. Housings shall be constructed of galvanized steel panels with structural members for rigidity. Housings shall have access panels for full access to all components, inlet and outlet duct connection flanges and a deep spun venturi inlet. Direct drive fans shall have motor, fan wheels shall be constructed of aluminum, be statically and dynamically balanced and backward curved, non-overloading type. Drives of belt drive fans shall have shafts mounted with heavy duty, permanently lubricated, sealed ball bearings and be equipped with variable pitch, cast iron pulleys. Drives shall be sized for a minimum of 150 percent of driven power. Motors shall have permanently lubricated,

sealed ball bearings and be factory wired with flexible leads and disconnect switches to permit service without disconnecting field wiring.

B. The following accessories shall be provided when indicated in the fan schedule:

1. Hanging or base mounted vibration isolators
2. Motor Cover/Belt Guard with or without insulation, as scheduled.
3. Insulated housing with fiberglass duct liner
4. Backdraft Dampers
5. Protective Coating

C. Manufacturers shall be Carnes, Acme, Greenheck or approved equals.

2.02 GENERAL

A. Provide and install fans and accessories as scheduled on the Drawings and specified in this Section.

B. Fan air performance ratings shall be in accordance with AMCA Standard 210.

C. Fan sound performance ratings shall be in accordance with AMCA Standard 300. Sound levels shall not exceed specified level at specified air delivery conditions.

D. Fan performance based on sea level conditions.

E. Equivalent fan selections shall not decrease motor horsepower (wattage), increase noise level, increase tip speed by more than 10 percent, from that specified.

F. Provide fans capable of accommodating static pressure variations of plus or minus 10 percent.

G. Provide balanced variable sheaves for all motors with the size selected at midpoint in the adjustment.

H. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building.

I. Provide belt guards on belt driven fans and safety screens where inlet or outlet is exposed.

J. Fan wheels and housings not of aluminum or stainless steel shall be factory primed inside and outside.

PART 3 - EXECUTION

3.01 CENTRIFUGAL IN LINE CABINET VENTILATORS

- A. Set and install in line fans as specified and indicated on the drawings.
- B. Equipment installation shall be such that filters, motors, bearings and belts can be easily serviced.
- C. Provide flexible connectors (specified elsewhere) at inlet and outlet of in line fans.
- D. All fans shall be checked for proper rotation and be lubricated before start up.

END OF SECTION

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**SECTION 15756
CEILING AND CABINET VENTILATORS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide Ventilating systems as indicated on the drawings and as specified herein with all accessories required for proper system balance.

1.02 REFERENCES

- A. Air Diffusion Council (ADC)
- B. Air Movement and Control Association (AMCA)
- C. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- D. National Fire Protection Association (NFPA)
- E. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- F. Underwriters Laboratories, Inc. (UL)

1.03 SUBMITTALS

- A. Submit catalog data and shop drawings for all materials and equipment listed under the section.

PART 2 - PRODUCTS

2.01 CEILING AND CABINET VENTILATORS

- A. Cabinet Mounted Centrifugal Fans shall be UL listed and bear the AMCA Seal for air and sound performance. Housings shall have an integral backdraft damper, be acoustically insulated, convertible to either horizontal or vertical discharge and equipped with a white intake grille. Fan wheel shall be direct driven, dynamically balanced, forward curved type. Motors shall have internal thermal overload protection, be compatible with speed controllers, mounted on vibration isolators and factory wired for easy disconnect for inspection and service.
- B. Ventilators shall be equipped with mounting brackets readily adapted to various mountings.

- C. The following accessories shall be provided when indicated in the fan schedule:
 - 1. Vibration Isolation
 - 2. Speed Control
 - 3. Protective coating
- D. Manufacturers shall be: Carnes, Greenheck, Acme or approved equals.

2.02 GENERAL

- A. Provide and install fans and accessories as scheduled on the Drawings and specified in this Section.
- B. Fan air performance ratings shall be in accordance with AMCA Standard 210.
- C. Fan sound performance ratings shall be in accordance with AMCA Standard 300. Sound levels shall not exceed specified level at specified air delivery conditions.
- D. Fan performance based on sea level conditions.
- E. Equivalent fan selections shall not decrease motor horsepower (wattage), increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 10 percent, from that specified.
- F. Provide fans capable of accommodating static pressure variations of plus or minus 10 percent.
- G. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of the building.
- H. Fan wheels and housings not of aluminum or stainless steel shall be factory primed inside and outside.

PART 3 - EXECUTION

3.01 CEILING AND CABINET VENTILATORS

- A. Set and install fans as specified and indicated on the drawings.
- B. Equipment installation shall be such that filters, motors, bearings can be easily serviced.
- C. Provide flexible connectors (specified elsewhere) at outlet of ceiling fans.
- D. All fans shall be checked for proper rotation and be lubricated before start up.

END OF SECTION

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**SECTION 15881
GALVANIZED SHEET METAL DUCTWORK**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide a galvanized sheet metal ductwork system as indicated on the drawings, complete with all accessories specified herein and as required for proper system operation and balance.

1.02 RELATED WORK

- A. Section 15258 - DUCTWORK INSULATION

1.03 REFERENCES

- A. Air Diffusion Council (ADC)
- B. Air Movement and Control Association (AMCA)
- C. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
- D. National Fire Protection Association (NFPA)
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- F. Underwriters Laboratories, Inc. (UL)

1.04 SUBMITTALS

- A. Submit catalogue data and shop drawings for all materials and equipment listed under this section.

PART 2 - PRODUCTS

2.01 GALVANIZED SHEET METAL DUCTWORK

- A. Sheet Metal Ductwork
 - 1. Galvanized steel ductwork shall be carbon steel, of lock-forming quality, hot dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A-527/A527M-G90.

2. Sheet metal gages and reinforcement shall conform to the latest edition SMACNA HVAC duct construction standards, with the exception that 24 gage will be the thinnest gage allowed for rectangular ductwork.

Round sheet metal ducts shall use the following gages:

| Duct Dia. | Max. 2" W.G. Positive Static Press. | Max. 10" W.G. Positive Static Press. | Max. 2" W.G. Negative Static Press. |
|--------------|---|--|---|
| 3-8 | 28 | 24 | 24 |
| 9-14 | 26 | 24 | 24 |
| 15-26 | 24 | 22 | 22 |
| 27-36 | 22 | 20 | 20 |
| 37-50 | 20 | 20 | 18 |
| 51-60 | 18 | 18 | 16 |
| 61-84 | 16 | 16 | 14 |

2.02 DUCTWORK SEALANT

- A. Sealant shall be non-flammable when wet, fire resistive when dry, and suitable for use in high velocity ductwork. Shall meet NFPA 90A and 90B and be UL classified. Sealant shall have a maximum 25 flame spread and 50 smoke developed (dry state) compound specifically for sealing ductwork.
- B. Tape for use with duct sealant shall be specifically designated by the manufacturer for ductwork sealing.

2.03 DUCTWORK ACCESSORIES

- A. General
 1. Provide duct accessories as indicated on the drawings and as required for proper system operation and balance.
- B. Flexible Duct Connections
 1. Flexible duct connections shall be UL listed fire retardant neoprene coated woven glass fiber fabric connections, shall conform to NFPA 90A and 90B and have a maximum flame spread rating of 25 and a maximum smoke development rating of 50.
 2. For static pressures up to 3", flexible connection fabric shall be 22 oz./sq. yard and 3" wide with 3" metal on either side of fabric. Equal to Duro Dyne #10105 MLN Metalfab or equal.

3. For static pressures 3" or greater, flexible connection fabric shall be 30 oz./sq. yard and 3" wide with 3" wide metal on either side of fabric. Equal to Duro Dyne #10003 MFN Metalfab.
- C. Manual Balancing Dampers
1. Dampers in rectangular ductwork of 12" depth or less shall be single blade type with extended shaft for damper quadrant. Dampers shall be Airstream, Model PBD-5, or approved equal.
 2. Dampers in rectangular ductwork of greater than 12" depth shall be opposed blade type, complete with tie rods, and with extended shaft for damper quadrant. Blades shall be 6" width, maximum. Dampers shall be Airstream, Model OBD-11, or approved equal.
 3. Dampers in round ductwork shall be single blade type with 20 gauge X 7" long galvanized steel frame and 20 gauge galvanized steel blade. Frames shall be beaded on each end. Shafts shall be 1/2" diameter, mounted with bearings and locking quadrant with insulation standoff. Dampers shall be Ruskin, Model MDRS25 or approved equal by Airstream, Air Balance, Louvers and Dampers or Vent Products.
 4. All dampers shall have an operable blade area equal to the duct net area. No blank off plates will be allowed in place of non-standard blade widths.
- D. Splitter Dampers shall be fabricated form 16-gauge steel with a hemmed leading edge; trailing edge shall be pivoted on a rod or hinges; install in accordance with the latest edition a SMACNA's Low Velocity Manual. Secure rod to leading edge of damper and extend rod through side of ductwork using Ventlock #603 ball joint bracket with set screw.
- E. Damper Quadrants shall have indicators showing open and closed positions, and shall be Ventfabrics, "Ventlock", as follows:
1. Dampers with shaft length 12" or less - No. 620 for base ductwork and No. 637 for insulated ductwork.
 2. Dampers with shaft length longer than 12" - No. 637.
- F. Turning Vanes
1. Turning Vanes shall be double thickness, 4.5 inches wide and spaced 3.25 inches apart, as manufactured by Barber Coleman, Titus, Airturns, or equal.
- G. Access Door
1. Duct Access Doors shall be UL labeled, galvanized steel, double panel construction, internally insulated with minimum 1 inch thick fiberglass insulation complete with gaskets and quick opening locking devices in accordance with SMACNA standards. Access doors shall be removable. Access doors with sheet metal screws are not acceptable.

2.04 DUCT LINER

- A. All ducts indicated on drawings to be internally lined shall be lined in accordance with specification Section 15258.

2.05 SPIN-IN COLLARS

- A. Spin-In Collars for round branch duct take-offs shall be factory fabricated from galvanized sheet metal and shall be in the following configurations as shown on the drawings.

1. Straight Spin-In

- a. Sizes 4" through 20" shall be 26" gage, Spin-In shall be equipped with a factory assembled adjustable damper with insulation standoff. Spin-In collars to be installed in internally lined duct shall be provided with an insulation guard. Scoops are not to be provided. Equal to JER-AIR model S-3.

2. Conical Spin-Ins

- a. Sizes 4" through 16" shall be 26 gage. Spin-In end of fitting shall be 2 inches larger than the branch duct size. Spin-In shall be equipped with a factory assembled adjustable damper with insulation standoff. Spin-in Collars to be installed in internally lined duct shall be provided with an insulation guard. Scoops are not to be provided. Equal to Metal Manufacture model MSIT-5.

2.06 INSULATED FLEXIBLE DUCTWORK

- A. Insulated flexible duct shall be listed under UL standard 181 as class 1 air duct and shall comply with NFPA standards 90A and 90B. The duct shall be 25/50 rated for flame spread/smoke developed.
- B. The duct shall be rated for 6 inches W.G. positive pressure and 2 inches W.G. negative pressure. The rated temperature range shall be 0 to 189 degrees F. The UL rated velocity shall be 4000 fpm.
- C. The duct shall be constructed with corrosion resistant steel wire helix permanently bonded to multiple layers of either reinforced aluminum foil polyester laminate or coated woven fiberglass.
- D. The duct shall be insulated with 1 1/2 inch thick, 3/4 pound density fiberglass blanket with a K value of 0.25 at 75 degrees F.
- E. The vapor barrier shall be fiber glass reinforced metallized film laminate with a permeance of 0.1 perm.

- F. Insulated flexible duct shall be equal to Wiremold Type WCK or Thermoflex Type M-KC.

PART 3 - EXECUTION

3.01 GALVANIZED SHEET METAL DUCTWORK

- A. Sheet Metal Ductwork shall be fabricated and installed per the latest edition of the SMACNA HVAC duct construction standards and ASHRAE Handbook.
- B. All ductwork shall be supported in accordance with SMACNA standards. All threaded rod supports shall be double nutted.
- C. Duct transitions shall be gradual, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct extended.
- D. All rectangular duct elbows shall be fabricated in accordance with either of the following:
 - 1. Radius Elbow - All radius elbows shall have a centerline radius equal to 1.5 times the width of the duct. This results in an inside radius equal to the width of the duct. Under no circumstances will radius elbows with a centerline radius of 0.5 times the duct width and an inside radius of 0.0 (90 degrees angle) be allowed.
 - 2. Mitered Elbow (Square Throat - Square Heel) - Where radius elbows will not fit, a mitered elbow will be required. All mitered elbows with an angle over 45 shall be provided with turning valves.
- E. All duct sizes shown on plans are net free area.

3.02 DUCT SEALANT

- A. All duct systems shall be sealed to meet SMACNA seal class C. Seal per SMCNA recommended methods with sealant or sealant plus tape as appropriate.

3.03 DUCTWORK ACCESSORIES

- A. Flexible duct connection shall be installed on all ductwork required to be attached to motor driven equipment.
 - 1. The ends of the flexible connection shall be overlapped and sealed, to prevent air leakage, per the manufacturers recommendations. If manufacturer does not have recommended method of sealing, the following method shall be used. Both ends of the flexible connection shall be extended three inches and turned inward (into air stream). Silicone caulking shall be applied between the overlap and outward clinching staples shall be used to fasten the lap.

- B. Manual Balancing Dampers, Splitter Dampers, Quadrant Dampers
 - 1. All damper shall be installed so that damper blades have a full range of movement without interference or binding. Damper quadrant shall be located to provide easy access.

- C. Turning Vanes

- 1. Turning vanes shall be installed in all mitered (Square Toe-Square Heel) elbows with an angle greater than 45 degrees. Turning vanes shall be 4.5 inches wide, on 3.25 inch centers and be double thickness.
 - 2. Turning vanes shall be installed tangent to the air stream.

3.04 SPIN COLLARS

- A. Spin collars shall be installed in accurately cut openings in the sheet metal duct work.
- B. Spin collars shall be suitably sealed for the pressure class required.
- C. The quadrant damper shall be checked for free movement and left in the full open position after the spin collar is installed.

3.05 INSULATED FLEXIBLE DUCTWORK

- A. For runouts to air distribution devices the length of flexible duct work shall not exceed 5 feet. For lengths of duct required over 5 feet, the remainder shall be galvanized steel round duct.
- B. Bends in flexible duct shall be made with not less than 1 duct diameter centerline radius. Extend flexible duct a few inches beyond end of sheet metal connection before bending.
- C. Flexible duct shall be installed and supplied in accordance with SMACNA standards.
- D. Flexible duct shall be secured to sheet metal duct with a draw band and independent of flexible duct insulation. The insulation shall be secured with a separate draw band.

END OF SECTION

**SECTION 15955
TEMPERATURE CONTROLS**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide a complete automatic temperature control system as indicated on the drawings and as specified herein for proper system control.
- B. Provide:
 - 1. Identification of Controls System Components
 - 2. Valves, Dampers and Actuators
 - 3. Control System Wiring and Conduit
 - 4. Portable Operators Terminal
 - 5. Sensors, Transmitters, Transducers, Relays, Enclosures
 - 6. Distributed Processing DDC
 - 7. Training of Operations Personnel
 - 8. As-Builts and Framed Approved Control Diagrams

1.02 SUBMITTALS

- A. Manufacturer's literature and data for all components including the following:
 - 1. Controllers
 - 2. Control Dampers, Control Valves and Actuators
 - 3. Temperature Control Panel Sizes and Faseplate Layout
 - 4. Instrumentation Products
- B. Control Drawings:
 - 1. AutoCAD drawing files.
 - 2. Three complete sets of prints

1.03 CONTROL SYSTEMS

- A. Furnish and install complete and ready for operation with control sequences as indicated on the drawings.

- B. Control equipment, except for items comprising an integral part of the water or refrigeration system, shall be installed by trained mechanic employed by the control contractor.
- C. Include the services of a full time control technician for calibrating controls for the first 5 working days after owner has occupied building.
- D. Before installation, submit for approval one set of reproducible drawings and one complete set of diagrams. Hang a photostatic copy of the approved diagram, framed behind glass in each mechanical room. Provide one set of reproducible "As-Built" control diagrams at completion of the project for the Owners use.
- E. Provide permanent nameplates for control switches and motor starters. Nameplates: Engraved laminated plastic with letters legible under normal operating conditions (White on Black).
- F. Permanently identify control devices other than room thermostats, so they may be identified on control diagrams. Provide engraved plastic nameplates for items mounted outside of or on faces of panels. Mark other instruments with indelible ink.
- G. The control contractor shall have a five year record of installation and service of temperature controls within 100 miles of the project area for similar types of systems. Acceptable manufacturers are Trane, Johnson Controls or approved equal.

1.04 CONTROL WIRING

- A. Include all control and interlocking wiring and power wiring for control panel in this section. Install in conduit in accordance with provisions of the electrical specifications.
- B. Firestop conduit penetrations of fire rated walls and partitions.
- C. Wire all devices individually to terminal strips in control panels.
- D. Furnish necessary relays and auxiliary contactors and other accessories required. Provide interlock relays per N.E.C. Coordinate start-up stations, auxiliary contacts, etc., with supplier of starters and motor control centers specified in electrical work.

PART 2 - PRODUCTS

2.01 DIRECT DIGITAL CONTROLLER (DDC)

- A. The DDC's shall be microprocessor based units that monitor the HVAC equipment through the proper control mode, maintain the desired conditions by operating the proper activators and switching devices. All control programs shall be resident in each DDC. Each controller shall contain all necessary electronic circuits utilizing state of the art

digital and microprocessor technology and shall be contained in a protective metal housing.

- B. Provide a minimum of 48 hours of battery back-up to protect the volatile memory of each controller.
- C. Failure of any other DDC or system processor shall not degrade the operation of other controllers in the system.

2.02 PORTABLE OPERATOR TERMINAL

- A. Provide a portable terminal capable of addressing all system parameters at each remote controller. The terminal shall be capable of readout and adjustment of all setpoints, temperatures, throttling ranges, reset times, rate control parameters, enthalpy, volume (CFM and GPM), time and date schedules, etc., via an LED display and shall provide for system entry via a keyboard or keypad arrangement.

2.03 ELECTRONIC TEMPERATURE SENSORS

- A. Electronic temperature sensors shall be of corrosion resistant construction, tamper proof, suitable for mounting on a vibrating surface.
- B. All duct mounted temperature sensors (except outdoor and return air) shall have a minimum 20 foot capillary average element.
- C. All sensing elements for water pipe mounting shall be furnished complete with protecting wells filled with heat conducting compound.
- D. Space temperature sensors shall be provided with room type locking covers.
- E. Sensors shall be factory calibrated and shall be thin film platinum.

2.04 ELECTRONIC STATIC PRESSURE SENSORS

- A. Electronic static pressure sensors shall be of the strain gauge type with 4-20 mA or 0-1 VDC output. Static accuracy shall be not more than 2% or span. Provide appropriate span for each application: 0-2" water column for duct static pressure and 0-0.5 inches of water column for velocity pressure. Sensors shall be Dwyer, Celesco, or approved equal.

2.05 ELECTRONIC DIFFERENTIAL PRESSURE SENSORS

- A. Electronic differential pressure sensors shall be of the industrial type with plus or minus 1% accuracy over the entire span of the instrument. Span shall be appropriate for the application. Approved manufacturers are ITE, Honeywell, Foxboro, Fisher, and Moore Industries. Use of pneumatic differential pressure sensors shall not be acceptable.

2.06 AUTOMATIC DAMPERS

- A. Automatic dampers shall be opposed blade type with adjacent blades rotating in opposite directions. They shall be furnished in standard sizes using damper louvers 4 inches in width. Damper blade length shall be a minimum of 12 inches to a maximum of 48 inches. Where larger dampers are required, provide the necessary shaft and blade linkages to allow multiple sections to operate as a single damper. Dampers shall be provided with solid stops for tight closing with vinyl seals on the blade edges and flexible metal compression type sides of the damper frame, which will stand a temperature of up to 200 degrees F. These stops shall be so assembled that they may be easily replaced if they become damaged. Dampers shall be tightly closing and shall be capable of less than 1% at the applied static pressure. Bearings shall be oilite or nylon. Dampers shall be provided with pneumatic operators of the proper size to provide the control sequence desired and shall be equipped with pilot positioners where required to provide sequence action. Damper linkage shall be provided either linear or equal percentage air flow the control system manufacturer to provide all necessary devices, electronic circuitry, and other equipment to make the output of the DDC system compatible with the motor controller. Pneumatic signals will not be acceptable for this purpose and shall not in any way be used to control the variable speed motor drives.

2.07 VALVE AND DAMPER ACTUATORS

- A. Electric valve and damper motors (where indicated) shall have oil immersed gear trains and spring return to normal position.

2.08 MISCELLANEOUS

- A. Capillary Supports: securely support all duct mounted and casing mounted thermostat capillaries using factory fabricated copper bulb supports.
- B. Provide standoffs for control devices mounted on externally insulated ducts and equipment.
- C. Anchor all items mounted on gypsum board (dry-wall) using toggle bolts or moly bolts, not expansion shields.
- D. Pressure Gauges:
 - 1. Provide 1-1/2" dial branch pressure gauges as close as possible to each valve and damper operator. Provide 1" minimum dial gauge on each port of each instrument, including transmitters and P.E.'s.

2.09 SOFTWARE

- A. Each direct digital controller shall contain all custom and standard programs necessary to accomplish the sequence of operation specified for the equipment it serves and perform the energy management function specified in the Data and Control Summary.

- B. All custom software to accomplish the sequence of control shall be generated in the manufacturer's local office and shall be tested and de-bugged prior to its installation at the job site. The DDC system shall provide a real time control language for user programming of HVAC application designed to accomplish easy transition from hardware control system design to software based control system design. The custom software shall allow the user to program custom control sequences directly into micro-computer memory. Provide a portable laptop computer with all software loaded and configured to control all devices through internet and direct connection. Provide a licensed backup copy of all software used in this project.

PART 3 - EXECUTION

3.01 FINAL ADJUSTMENT

- A. Adjustments shall be performed by a factory trained technician to make all final control adjustments. The Temperature Control Contractor shall work closely with the Testing, Adjusting and Balancing contractor to troubleshoot and calibrate systems installed under this section for proper operation and balance.

3.02 TRAINING FOR OPERATION PERSONNEL

- A. The Temperature Controls Contractor shall conduct suitable training period for the Owner's representative to properly explain all facets of the control system operation.

3.03 ACCEPTANCE, GUARANTEE AND SERVICE

- A. All components, parts, and assemblies shall be guaranteed against defects in workmanship and materials per 01740. In addition, the Control Contractor shall provide prevention maintenance, operator instruction, and system maintenance training through one (1) full heating and cooling season.

END OF SECTION

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**SECTION 15980
TESTING, ADJUSTING, AND BALANCING**

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. A. Provide all labor, equipment and instrumentation necessary to perform the testing, adjusting and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems which shall include, but not be limited to:
 - 1. Supply air systems
 - 2. Return air systems (including plenum returns)
 - 3. Exhaust air systems
 - 4. Outside air
 - 5. Mixed air
 - 6. Adjustment of controls and equipment as required for proper operation of systems
 - 7. Air leakage testing of ductwork
 - 8. Heat transfer equipment
 - 9. Adjust all systems to maintain building pressure design

1.02 REFERENCES

- A. A. Associated Air Balance Council (AABC)
- B. National Environmental Balancing Bureau (NEBB)
- C. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- D. Sheet Metal and Air Conditioning Contractor's Association (SMACNA)

1.03 THE TAB AGENDA

- A. The TAB Agenda Contractor shall prepare a TAB agenda for review and approval by the Engineer. The TAB Agenda shall be provided during the submittal process. The TAB Contractor shall not commence work until the TAB Agenda has been approved by the Engineer.
- B. The Agenda shall include the following detailed narrative procedures, system diagrams and forms for test results.

1. Specific standard procedures required and proposed for each system. Additional procedures for variable flow systems shall be developed by the TAB Contractor and included for review and approval.
2. Specific test forms for recording each TAB procedure and additional test forms for any variable flow systems shall be developed by the TAB Contractor and submitted for review and approval.
3. System diagrams for each air system. Diagrams may be single line. In addition to the information recorded for standard AABC or NEBB procedures, report the following information:
 - a. Air handling units: Prepare profile and show design and actual CFM (outside air, return air, supply air). Measure and record each mode (minimum OA and 100% OA) where economizer cycle is specified. Record pressure drops of all components (coils, heat recovery devices, filters, sound attenuators, louvers, dampers, fans) and compare with design values. Pressure profile and component pressure drops are performance indicators and are not to be used for flow measurements. Set and record purge air flow for heat recovery wheels. Record temperatures of outside air, return air, mixed air and supply air.
 - b. Duct distribution systems: Prepare pressure profiles from the air handling units to the extremities of the system. As a minimum, show pressures at each floor, main branch, and air flow measuring device. Make pitot tube traverses of all trunk lines and major branch lines where required for analysis of distribution system. Air flow measuring devices installed in ductwork may be utilized. Record residual pressures at inlet of volume controlled terminals at ends of system. Show actual pressures at all static pressure control points utilized for constant or variable flow systems.
 - c. Variable flow systems: Include specific test forms provisions for measuring and reporting CFM (supply, return, exhaust, outside), system pressures, motor loads, other pertinent data, at full unthrottled capacity and at design (100 percent) flows. Record additional flow, pressure, and motor loads for supply and return/exhaust system capacities in 10 percent increments down to a minimum attainable by the system to verify fan tracking and control. Modulate Systems by varying the supply temperature of the medium or other approved means.
4. Specific test forms for recording sound and vibration measurements.

1.04 SUBMITTALS

- A. The TAB Contractor shall submit the following items prior to commencing work. All submittals shall be bound in a binder complete with cover sheet, index, and tabs separating specific sections of the submittal.
 1. The TAB agenda as detailed in paragraph 1.03-A

2. Warranty information
 3. TAB Contractor qualifications including TAB Engineer and company experience on similar projects
 4. Submit project supervisor and qualifications
 5. Submit TAB equipment and last date of calibration
- B. After completion of all TAB procedures and before warranty period commences, submit complete test reports as provided for by the prior approved TAB agenda, for Engineer review and approval. Where test results differ from specified design conditions, indicating a contract deficiency, include explanatory comments and possible resolutions in the report. After review by the Engineer, the TAB Contractor shall make any adjustments deemed necessary by the Engineer.
- C. Final report shall be submitted for acceptance and record. Submit six (6) copies of final reports.

1.05 WARRANTY

- A. For a period of one year after acceptance by the Owner, the TAB Contractor shall, at the request of the Engineer, return to the project to retest and/or rebalance any problem areas. This shall be done within ten (10) working days at no additional expense to the Owner or the Engineer. The purpose of this is to correct a problem, not to retest/rebalance revisions made by the Owner.
- B. During the first year after acceptance by the Owner, the TAB Contractor shall return to the project during the peak heating and cooling seasons to rebalance the applicable systems to maintain the required discharge air temperatures. The T&B report shall be amended to reflect the results.

PART 2 - EQUIPMENT (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. The TAB Contractor shall review and become thoroughly familiar with the job site when the erection of the building is in the early stages. An additional visit shall be made when the rough-in is complete. Prior to any closing in of ductwork and piping, verify that all fittings, dampers, control devices, test devices and valves are properly located and installed.
- B. The TAB Contractor shall examine each distribution system to verify that it is free from obstructions. The TAB Contractor shall determine that all dampers, registers and valves

are in a set or full open position; that moving equipment is lubricated; and that the required filters are clean and functioning. The TAB Contractor shall request that the installing contractor perform air adjustments necessary for proper functioning of the system.

- C. The TAB Contractor shall use test instruments that have been calibrated within a time period recommended by the manufacturer (no more than 6 months) and have been checked for accuracy prior of the start of the testing, adjusting and balancing.
- D. The TAB Contractor shall verify that all equipment performs as designed and specified. The TAB Contractor shall adjust all variable type drives, volume dampers, control dampers, balancing valves, control valves, etc., as required by the TAB work.
- E. Coordinate TAB procedures with all construction requirements for the project so that usable increments of finished work may be accepted for beneficial occupancy. Systems serving partially occupied phases of the project may require balancing for each phase prior to final balancing.
- F. Allow sufficient time in construction schedule for TAB prior to final inspection for the project.
- G. Conduct final TAB after system has been completed and is in full working order. Put all HVAC systems into full operation and continue operation of the systems during each working day of TAB. Accomplish TAB in accordance with the Agenda approved by the Engineer.

3.02 AIR BALANCE

- A. Place all interactive systems in operation with all filters installed and automatic control systems completed and operating. Artificially load air filters by partial blanking or other means to produce air pressure drop midway between the clean and dirty condition. Set/reset room thermostats as necessary to check heating and cooling function, and maximum/minimum flow rates for factory set air terminal units and adjust units if not correct.
- B. Balance systems to design ratings. Adjust fan speeds to provide design flows, including system diversities, at actual system pressures. Provide additional sheaves and belts as required to achieve design CFM. Coordinate VAV balancing, including supply and return fan volume controls, with the controls Contractor and set supply fan static pressure control as low as practicable and still maintain required pressure at the remote terminal units.
- C. Make pilot tube traverses of all trunk lines and major branches when required to determine proper proportioning of air flows. Air flow measuring devices, where installed, may be utilized for this purpose.

- D. Record pressure drop readings across all major system components and significant drops within duct systems.
- E. Adjust air systems with doors leading outside closed. Balance individual rooms simulating occupied conditions. (Windows and doors closed, etc.)
- F. Log air flows for occupied and unoccupied conditions.
- G. Make flow and pressure measurements at each terminal device, and each supply, return, or exhaust diffuser. Adjust each air outlet unit within plus or minus 10 percent of design requirements, but total air for each system shall be not less than shown. Adjust grilles and diffusers to minimize drafts in all areas. Maintain the building pressure relationships between different zones.
- H. Adjust outside air and return air quantities for all systems to within plus or minus 10 percent. Total supply air quantity for any system shall be not less than shown.
- I. Adjust exhaust systems to CFM requirements.
- J. Test function of automatic dampers and operation of air terminal units. Check all controls for proper operation.

3.03 HEAT TRANSFER EQUIPMENT DATA

- A. A. For all heat transfer equipment, which for the purposes of this specification section shall include coils, etc.
- B. The following data shall be measured and included in the TAB report:
 - 1. Ambient conditions, dry bulb, wet bulb, relative humidity
 - 2. Entering air wet bulb and dry bulb
 - 3. Entering relative humidity
 - 4. Leaving air we bulb and dry bulb
 - 5. Leaving air relative humidity
 - 6. Air pressure drops

3.04 AIR LEAKAGE TESTING OF DUCTWORK

- A. Ductwork leakage shall be tested in accordance with SMACNA manual, "HVAC Air Duct Leakage Test Manual", latest edition.

3.05 VIBRATION TESTING

- A. Furnish instruments and perform vibration measurements as specified in Section, NOISE VIBRATION AND SEISMIC CONTROL. Field vibration balancing is specified in Section, BASIC METHODS AND REQUIREMENTS. Provide measurements for all rotating HVAC equipment 1/2 horsepower and larger, including centrifugal compressors, fans and motors.
- B. Record initial and final measurements for each unit of equipment on test forms. Where vibration readings exceed the allowable tolerance and efforts to make corrections have proved unsuccessful, forward a separate report to the Engineer.

3.06 SOUND TESTING

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section, NOISE AND VIBRATION CONTROL. Take readings in rooms, approximately ten percent of total rooms, designated by the Engineer.
- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- C. Sound reference levels, formulae and coefficients shall be according to ASHRAE Handbook, 1987 SYSTEMS AND APPLICATIONS Volume, Chapter, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
 - 1. Where sound pressure levels are specified, including the NC Criteria in Section, NOISE AND VIBRATION CONTROL.
 - a. Reduce the background noise as such as possible by shutting off unrelated audible equipment.
 - b. Measure octave band sound pressure levels with specified equipment "off".
 - c. Measure octave band pressure levels with specified equipment "on".
 - d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE: 0 1 2 3 4 5 - 9 10 or more
FACTOR: 10 7 4 3 2 1 0

- e. Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.
- f. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.

2. When sound power levels are specified:
 - a. Perform steps 1.a. thru 1.d., as above.
 - b. For in equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
 - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor.
 3. Where sound pressure levels are specified in terms of dbA, measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.
- E. Where measured sound levels exceed specified level, the installing Contractor or equipment manufacturer shall take remedial action approved by the Engineer and the necessary sound tests shall be repeated.

END OF SECTION

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