

SECTION 23 05 48.00 40

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
05/22

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.71 (1983; R 2006) Guide to the Evaluation of
Human Exposure to Vibration in Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK (2016) HVAC Applications Handbook, I-P
Edition

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV (2006) Procedural Standards for
Measurements and Assessment of Sound and
Vibration

1.2 ADMINISTRATIVE REQUIREMENTS

Within ten working days of Contract Award, submit **equipment and performance data** for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure the data includes information on the following:

- a. Mountings
- b. Bases
- c. Isolators
- d. Floor-Mounted Piping
- e. Vertical Piping

Five working days prior to commencement of installation, submit **installation drawings** for vibration isolator systems including equipment and performance requirements.

Indicate within **outline drawings** for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights

of equipment.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

Outline Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Isolators; G

SD-06 Test Reports

Type of Isolator; G

Type of Base; G

Allowable Deflection; G

Measured Deflection; G

1.4 QUALITY CONTROL

Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB MASV.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in paragraph EQUIPMENT, means longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

2.1.1 Design Requirements

Design for vibration isolation using NEBB MASV and ASHRAE HVAC APP IP HDBK, Chapter 48, as applicable to the following sections.

2.1.1.1 Mountings

Provide the following mountings:

Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.

Type B: Double rubber-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50-inch are allowed.

Type C: Free-standing laterally stable open-spring type for deflections over 0.50-inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 0.50-inch clearance maintained around springs, with adjustable limit stops, 0.25-inch thick Type A base elastomer pads, and accessories.

Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow maximum movements of 0.25-inch in each direction, 0.25-inch thick Type A base elastomer pads.

Type F: Combination spring and rubber-in-shear steel framed for hanger-rod mounting, with minimum total static deflection of 1-inch.

Type G: Air spring with body constructed of reinforced elastomer specifically suitable for application environment. Select air spring to provide a natural frequency equal to 5-inches of deflection of conventional specified steel springs. Provide facilities for dead-level adjustment and height-control of supported equipment.

2.1.1.2 Bases

Provide the following bases:

Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.

Type R: Rails, connected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.

Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between

isolators. Minimum height is 5-inches.

Type CIB: Provide concrete inertia blocks common to the entire assembly, with welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8-inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts. Fill with 3,000 psi cured-strength concrete.

Configure rectangular inertia bases to accommodate equipment supported.

Ensure minimum thickness of inertia base, in addition to providing suitable mass, is sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components, and is sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Verify minimum thickness, the preceding requirements notwithstanding, is 8 percent of the longest base dimension.

2.2 EQUIPMENT

Vibration isolation design per NEBB MASV and ASHRAE HVAC APP IP HDBK, Chapter 37.

2.2.1 Pipe And Duct Vibration Isolation

Type G: Provide isolators with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 1-inch and 3/8-inch, respectively.

Type H: Provide isolators with contained chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8-inch.

Type J: Provide isolators with elastomers mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8-inch.

2.2.1.1 Floor-Mounted Piping

Type K: Provide isolators with springs mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum spring static deflection of 1-inch.

2.2.1.2 Vertical Piping

Type L: Provide isolators which are pipe base-support devices with one or more contained steel springs. Load devices by supported system during operating conditions to produce a minimum static deflection of 1-inch. Equip devices with precompression and vertical-limit features, as well as a minimum 1/4-inch thick elastomer sound pad and isolation washers, for mounting to floor.

Type M: Provide isolators which are elastomer mounted baseplate and riser pipe-guide devices, with contained double acting elastomer elements which under rated load have a minimum static deflection of [3/8-inch](#). Size isolator to accommodate thermal insulation within the stationary guide ring.

2.3 MATERIALS

Ensure rubber is natural rubber and elastomer is chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit test reports for testing vibration isolation for each [type of isolator](#) and each [type of base](#). Meet referenced standards contained within this section. Include in test reports [allowable deflection](#) and [measured deflection](#) also meeting referenced standards within this section.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than [1-inch](#) above the floor and are level when equipment supported is under operating load.

Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests and Reports

Ensure vibration-isolation devices are deflection tested. Submit test reports substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Contracting Officer.

-- End of Section --

SECTION 33 30 00

SANITARY SEWERAGE
05/18

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C600	(2017) Installation of Ductile-Iron Mains and Their Appurtenances
AWWA C605	(2014) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVC0) Pressure Pipe and Fittings
AWWA C900	(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA C909	(2016) Molecularly Oriented Polyvinyl Chloride (PVC0) Pressure Pipe, 4 In. (100 mm) and Larger

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C150/C150M	(2020) Standard Specification for Portland Cement
ASTM C270	(2019) Standard Specification for Mortar for Unit Masonry
ASTM C443	(2020) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals

ASTM C1244	(2011; R 2017) Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2321	(2020) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2011) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3139	(2019) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007; R 2020) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
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1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's License; G

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Precast Concrete Manholes

Frames, Covers, and Gratings

Gravity Pipe

Pressure Pipe

Gaskets

Special Coatings

SD-06 Test Reports

Precast Concrete Sewer Manhole Test; G

Hydrostatic Sewer Test; G

Negative Air Pressure Test; G

Low-Pressure Air Tests; G

Tests For Pressure Lines; G

Deflection Testing

Special Coatings Testing

SD-07 Certificates

Portland Cement

Gaskets

Pre-Installation Inspection Request; G

Post-Installation Inspection; G

1.3 QUALITY CONTROL

1.3.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Verify installing Contractor's License is current and state certified or state registered.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.4.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of

handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.4.1.2 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench. Store solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe in accordance with the manufacturer's recommendation and discard those materials if the storage period exceeds the recommended shelf life. Discard solvents in use when the recommended pot life is exceeded.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Sanitary Sewer Gravity Pipeline

Provide mains and laterals of polyvinyl chloride (PVC) plastic pipe. Provide building connections of polyvinyl chloride (PVC) plastic pipe. Provide new exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

2.1.2 Sanitary Sewer Pressure Lines

Provide pressure lines of polyvinyl chloride (PVC) plastic pressure pipe.

2.2 MATERIALS

Provide materials conforming to the respective specifications and other requirements specified below. Submit manufacturer's product specification, standard drawings or catalog cuts.

2.2.1 Gravity Pipe

2.2.1.1 PVC Gravity Sewer Piping

2.2.1.1.1 PVC Gravity Pipe and Fittings

ASTM D3034, SDR 35, with ends suitable for elastomeric gasket joints.

2.2.1.1.2 PVC Gravity Joints and Jointing Material

Provide joints conforming to ASTM D3212. Gaskets are to conform to ASTM F477.

2.2.2 Pressure Pipe

2.2.2.1 PVC Pressure Pipe and Associated Fittings

Pipe, couplings and fittings are to be manufactured of materials conforming to AWWA C909, Pressure Class 165 psi. Pipe compound shall conform to ASTM D1784, Class 12454B.

Provide joints conforming to ASTM D3139 and gaskets conforming to ASTM F477.

2.2.3 Cement Mortar

Provide cement mortar conforming to ASTM C270, Type M with Type II cement.

2.2.4 Portland Cement

Submit certificates of compliance stating the type of cement used in manufacture of precast manholes. Provide portland cement conforming to ASTM C150/C150M, Type II for concrete used in manholes and type optional for cement used in concrete cradle, concrete encasement, and thrust blocking.

2.2.5 Portland Cement Concrete

Provide portland cement concrete conforming to ASTM C94/C94M, compressive strength of 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement is to have a compressive strength of 2500 psi minimum at 28 days. Protect concrete in place from freezing and moisture loss for 7 days.

2.2.6 Precast Concrete Manholes

Provide precast concrete manholes, risers, base sections, and tops conforming to ASTM C478 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser are to be monolithic.

2.2.7 Gaskets and Connectors

Provide gaskets for joints between manholes and sections conforming to ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole are to conform to ASTM C923.

2.2.8 Frames, Covers, and Gratings for Manholes

Submit certification on the ability of frame and cover to carry the imposed live load. Frame and cover are to be cast gray iron, ASTM A48/A48M, Class 35B. Frames and covers are to be circular without vent holes. Size are to be as indicated on the plans. Stamp or cast the words "SANITARY SEWER" into covers so that it is plainly visible.

2.2.9 Manhole Steps

Zinc-coated steel conforming to 29 CFR 1910.27 As an option, plastic or rubber coating pressure-molded to the steel may be used. Provide plastic coating conforming to ASTM D4101, copolymer polypropylene. Rubber is to conform to ASTM C443, except shore A durometer hardness is to be 70 plus or minus 5. Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 4 feet deep.

2.2.10 Manhole Ladders

Provide a zinc hot-dip galvanized coated steel ladder where the depth of a manhole exceeds 12 feet. The ladder is not to be less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers are to be a minimum 3/8 inch thick and 2 inches wide. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M.

2.2.11 Special Coatings

- a. Except as otherwise specified or permitted by the Contracting Officer, special coatings shall be appropriate for their intended use as indicated by the Drawings and/or existing conditions.
- b. Primers shall be supplied by the same manufacturer as the finished coatings and shall be fully compatible with the coatings as well as the surface to which the special coatings are to be applied.
- c. Special coatings shall be of the epoxy based resin type, especially formulated to resist the corrosive action of hydrogen sulfide, acids, alkalis, salts, solvents, lubricating oils and greases. Coatings shall also be suitable for installation on wet concrete and be moisture and sewage-resistant.
- d. All materials shall be factory pre-weighed and pre-packaged in easy to manage containers to eliminate on-site mixing errors.
- e. Special coatings for the wetwells and sewer manholes shall have the following properties:
 1. Materials shall be sprayable or applied by roller or trowel.
 2. Materials shall be suitable for application to vertical surfaces.
 3. Physical properties:

Compressive Strength (ASTM C-109) 5,000 psi (min)
Tensile Strength (ASTM C-190) 700 psi (min)
Abrasion Resistance (ASTM D-4060) 44.9 mg weight loss (avg)
Application Time (ASTM C-308) 30 minutes

- f. Provide a DFT of epoxy coating on concrete surfaces as recommended by the manufacturer.
- g. Acceptable coating products are Sewergard Glaze No. 210G by Sauereisen; equivalent product by Blome Industries, or equal.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Installation Drawings

Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.

3.1.2 Preparation of Surfaces for Special Coatings

- a. All surfaces to be coated shall first be cleaned in an approved manner and shall be thoroughly dry prior to the application of any primers

and/or finished coatings. No work shall be done until the condition of the surface to which materials are to be applied has been inspected and approved by the Contracting Office.

- b. All surfaces to receive resurfacing material and/or epoxy coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the resurfacing material and/or epoxy coating and substrate, in accordance with the following surface preparation standards: Concrete: SSPC-SP13/NACE No. 6 "Surface Preparation of Concrete with a minimum angular surface profile of 1-1.5 mils.
- c. Prepare concrete joint and install sealant following resurfacing material installation.

3.2 INSTALLATION

Backfill after inspection by the Contracting Officer. Before, during, and after installation, protect plastic pipe and fittings from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer.

3.2.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.2.1.1 Location

Terminate the work covered by this section at a point approximately 5 feet from the building, unless otherwise indicated. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 2 feet below bottom of water line. When these separation distances can not be met, contact the Contracting Officer for direction.

3.2.1.1.1 Sanitary Piping Installation Parallel with Water Line

3.2.1.1.1.1 Normal Conditions

Install sanitary piping or manholes at least 10 feet horizontally from a water line whenever possible. Measure the distance from edge-to-edge.

3.2.1.1.1.2 Unusual Conditions

When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:

- a. The top (crown) of the sanitary piping is to be at least 18 inches below the bottom (invert) of the water main.
- b. Where this vertical separation cannot be obtained, construct the sanitary piping with AWWA-approved ductile iron water pipe pressure and conduct a hydrostatic sewer test without leakage prior to backfilling.
- c. The sewer manhole is to be of watertight construction and tested in

place.

3.2.1.1.2 Installation of Sanitary Piping Crossing a Water Line

3.2.1.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

3.2.1.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

- a. Construct sanitary piping passing over or under water lines with AWWA-approved ductile iron water pressure piping and conduct a hydrostatic sewer test without leakage prior to backfilling.
- b. Protect sanitary piping passing over water lines by providing:
 - (1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.
 - (2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.
 - (3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints are equidistant and as far as possible from the water line.

3.2.1.1.3 Sanitary Sewer Manholes

No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.2.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 11 00 CLEARING AND GRUBBING 31 23 00.00 20 EXCAVATION AND FILL.

3.2.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay non-pressure pipe with the bell ends in the upgrade direction. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Construct branch connections by use of regular fittings or solvent cemented saddles as approved. Provide saddles for PVC pipe conforming to Table 4 of ASTM D3034.

3.2.2 Special Requirements

3.2.2.1 Installation of PVC Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.2.2.2 Installation of PVC Pressure Pipe

Unless otherwise specified, install pipe and fittings in accordance with AWWA C605. AWWA C605 includes requirements such as excavation, installation, and placement of appurtenances.

3.2.2.2.1 Pipe 4 inch Diameter And Larger

Make push-on joints with AWWA C900 pipe with integral elastomeric gasket. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel. For push-on joint connections to fittings, use cut spigot end of pipe off square, marked to match the manufacturer's insertion line and beveled to match factory supplied bevel. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make mechanical-joints or flanged joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories or with the applicable requirements of AWWA C600 for ductile iron joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for mechanical-joint or flanged joint connections and do not bevel.

3.2.2.2.2 Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.2.3 Concrete Work

Cast-in-place concrete is included in Section 03 30 00 CAST-IN-PLACE CONCRETE. Support the pipe on a concrete cradle, or encased in concrete where indicated or directed.

3.2.4 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside

contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete piping. Parging will not be required for precast concrete manholes. Perform cast-in-place concrete work in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.2.5 Miscellaneous Construction and Installation

3.2.5.1 Connecting to Existing Manholes

Connect pipe to existing manholes such that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. Center the connection on the manhole. Holes for the new pipe are to be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cut the manhole in a manner that will cause the least damage to the walls.

3.2.5.2 Metal Work

3.2.5.2.1 Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.2.5.2.2 Field Painting

After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal, remove mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.2.6 Special Coating Application

- a. All surfaces shall be inspected during and after preparation and prior to application of the epoxy coating system. Any evidence of remaining contamination or latencies shall be removed by additional water or abrasive blast, or other method approved by the manufacturer before

proceeding with application of the epoxy coating system.

- b. All surfaces shall be smooth and even.
- c. Application procedures shall conform to the requirements of the manufacturer, including material handling, mixing, and environmental controls during application, safety, and equipment.
- d. Apply epoxy coating system within the manufacturer's required surface and material temperature ranges and any other environmental conditions.
- e. The equipment shall be specially designed to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order.
- f. Resurfaced concrete be coated with the epoxy coating system as specified.
- g. The epoxy coating shall be placed and cured in one (1) application.
- h. Requirements for safety and ventilation shall be in accordance with manufacturer's application requirements.

3.3 FIELD QUALITY CONTROL

The Contracting Officer will conduct field inspections and witness field tests specified in this section. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.3.1 Tests

Perform field tests and provide labor, equipment, and incidentals required for testing.

3.3.1.1 Hydrostatic Sewer Test

When unusual conflicts are encountered between sanitary sewer and waterlines a hydrostatic pressure sewer test will be performed in accordance with the applicable AWWA standard for the piping material or AWWA C600.

3.3.1.2 Leakage Tests for Non-pressure Lines

Test lines for leakage by negative air pressure tests. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.3.1.2.1 Negative Air Pressure Test

3.3.1.2.1.1 Precast Concrete Manholes

Test precast concrete sewer manhole test in accordance with ASTM C1244. The allowable vacuum drop is located in ASTM C1244 Make calculations in accordance with the Appendix to ASTM C1244.

3.3.1.2.2 Low-Pressure Air Tests

3.3.1.2.2.1 PVC Pipelines

Test PVC pipe in accordance with UBPPA UNI-B-6. The allowable pressure drop is located in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.3.1.3 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 50 psi in excess of the maximum working pressure of the system, but not less than 100 psi, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.3.1.3.1 PVC Pressure Pipe

Test PVC pressure pipe in accordance with the requirements of AWWA C605 for hydrostatic and leakage tests. The quantity of water that must be supplied during testing is not to exceed the quantity of water calculated in accordance with AWWA C605 to maintain the specified test pressure within 5 psi.

3.3.1.4 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads is not to exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3.3.1.4.1 Pull-Through Device

This device is to be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Space circular sections on the shaft so that the distance from external faces of front and back sections will equal or exceed the diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections are to conform to the following:

- a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
- b. Homogeneous material throughout, is to have a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.

- c. Center bored and through-bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.
- d. Suitably Back each eye or loop with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.3.1.4.2 Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and be accurate to 1.0 percent of the indicated dimension. Prior approval is required for the deflection measuring device.

3.3.1.4.3 Pull-Through Device Procedure

Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

3.3.1.4.4 Deflection measuring device procedure

Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.3.1.5 Dye Test

Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Use nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report as required in 01 45 00.00 20 Quality Control.

- a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.
- b. During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.

3.3.1.6 Special Coatings Testing

- a. Prior to application of epoxy coating system, Contracting Officer shall visually inspect the resurfacing material.
- b. Resurfaced areas shall pitch to drains, when present.
- c. The epoxy coating thickness shall be measured using a wet film thickness gauge, meeting ASTM D4414 by the Contractor's Independent Testing Laboratory.
- d. After the system has set hard to the touch it shall be inspected by Contractor's Independent Testing Laboratory and verifying the following:

1. Contractor's Independent Testing Laboratory shall measure the system-cured thickness from a specimen retrieved by the Contractor. Retrieval can be made by physically cutting through the epoxy liner (by drilling or coring) or a suitable non-destructive type of thickness measurement may also be used, (e.g., ultrasonic thickness testing).
 2. All pipe connections shall be open and clear.
 3. No cracks, voids, pinholes, uncured spots, dry spots, lifts, delamination or other type of defects shall be evident in the system.
- e. The epoxy coating shall be tested by the Contractor's Independent Testing Laboratory for holidays, pinholes, and discontinuities in accordance with NACE SP0188. All holidays, pinholes and discontinuities shall be properly repaired in accordance with the manufacturer's instructions and retested at no additional cost to the Owner; spark testing shall be conducted at 100 volts per mil.
- f. Contractor's Independent Testing Laboratory shall measure the bond strength of the epoxy coating system on at least four (4) locations for each substrate as directed by the Contracting Officer. Bond strength shall be measured in accordance with ASTM D4541. Further bond tests shall be performed in that area to determine the extent of potentially deficient bonded area, and repairs shall be made by the Contractor in strict accordance with the manufacturer's recommendations, at no additional cost to the Owner.
- g. A final visual inspection shall be made by the Contracting Officer and the Contractor. Any deficiencies in the epoxy coating system shall be marked and repaired according to the procedures set forth herein by the Contractor, at no additional cost to the Owner. The system shall be put back into operational service as soon as the final inspection has taken place.

3.3.2 Inspection

3.3.2.1 Pre-Installation Inspection

Prior to connecting the new service, perform pre-installation inspection after trenching and layout is complete. Submit pre-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the pre-installation inspection.

3.3.2.2 Post-Installation Inspection

Perform a post-installation inspection after connection has been made and before the connection is buried. Submit post-installation inspection request for field support at least 14 days in advance. The Installation's Utilities Field Support personnel will perform the post-connection inspection. During the post-installation inspection the Contractor will be responsible for performing a dye test.

-- End of Section --