

INFRASTRUCTURE DESIGN STANDARDS

THE CITY OF NEW YORK DEPARTMENT OF ENVIRONMENTAL PROTECTION

SPECIFICATIONS FOR TRUNK MAIN WORK

June 1, 2026



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Department of
Design and
Construction



INTRODUCTION

This publication has been prepared by the New York City Department of Design and Construction (“NYCDDC” or “the Department”) to provide a compilation of standard requirements, called specifications, used by the New York City Department of Environmental Protection (“NYC DEP”) for trunk water main construction. These specifications define the Contractor’s responsibility in meeting the contract requirements, enumerate the Department’s expectations, define how the Department will measure and pay for the work, and explain what the Contractor is expected to provide. When this publication, entitled Specifications for Trunk Main Work and dated June 1, 2026, is incorporated by reference into the Department’s construction contracts, it is made a part of that document.

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DIVISION 1. GENERAL REQUIREMENTS

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GENERAL PROVISIONS

1.1. INTENT

It is the intention of this part of the specifications to describe the materials and workmanship entering into the fabrication, shop testing, and delivery of the items for an electrically welded steel pressure main, 24" in diameter and larger, with all necessary appurtenances. Wherever Standard Specifications and Standard Drawings are listed in these Specifications, it will mean the latest revisions in effect on the date of the Bid.

1.2. WORK INCLUDED

The Contractor must furnish and deliver the steel pipe and appurtenances indicated on the drawings. Steel pipe and plate steel specials must comply with the requirements of this specification and the latest revision of AWWA C200 *Steel Water Pipe, 6 In. (150 mm) and Larger*. Ductile-iron pipe and ductile-iron specials must comply with the requirements of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**. Where there may be a conflict between the AWWA standards and this specification, this specification will prevail.

SUBMITTALS

1.3. SHOP DRAWING SUBMITTALS

(A) SCHEDULE OF SHOP DRAWING SUBMITTALS AND APPROVALS

- (1) Within thirty (30) calendar days after the date specified in a written notice signed by the Commissioner, and as further described in **Article 8** of the Contract, the Contractor must prepare and submit complete geometry drawings as described in **Section 1.6** as well as shop drawings, which are based on the pipe geometry for the first two thousand (2,000) feet (609.6 m.) of pipe scheduled for this contract.

(B) EXISTING SAMPLING STATIONS

Any existing sampling station will be reconnected to the new water main to the satisfaction of the Engineer. There will be no extra payment to the Contractor for this work, including removal, temporary storage, and re-installation of the sampling station and appurtenances, as required. If any damage occurs, the Contractor must repair such damage at own expense to the satisfaction of the Engineer. The Contractor will submit shop drawings showing details of the sampling station connection to the new water main for review and approval by the Engineer prior to construction.

(C) STANDARD VALVE CHAMBERS

- (1) The Contractor is advised that the dimensions and layouts of the various components within the standard chambers may differ from those shown on the standard drawings. The Contractor must verify all dimensions and accordingly alter roof slabs and/or chamber dimensions for operational access to the valves. Shop drawings detailing all alteration work to the roof slabs and/or chamber will be submitted to the Engineer for review and approval prior to chamber construction. The cost for this alteration work will be deemed included in the appropriate bid items provided in the contract. No additional or separate payment will be made for this alteration work.
- (2) For regulator valve chambers, the opening for the manway access (casting where the steps are located) will be on the side (determined by pipe centerline) of the chamber where the regulator control components and sump pit are located. Regulator valve chambers must be located completely within a sidewalk or mall area and not within roadway areas.
- (3) Any relocation of chambers due to field conditions must be approved by the Engineer.

1.4. DRAWINGS FURNISHED BY THE CONTRACTOR

The Contractor will furnish whenever required, drawings showing in detail the materials and construction of any part of the mains and appurtenances for which the Engineer does not issue detail drawings. No time will be allowed for delays caused by the Contractor submitting drawings that are not in accordance with the specifications. The Contractor will check all dimensions and quantities on the drawings or schedule given to the Contractor by the Engineer, and will notify the Engineer of all errors therein which the Contractor may discover.

1.5. AS-BUILT DRAWINGS

(A) DETAILS, DISTANCES, AND COORDINATES TO DOCUMENT ON AS-BUILT DRAWINGS

- (1) Lines and grades must meet the requirements of **Section 10.09** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.
- (2) Show the station of a perpendicular curb line, identifying where the job started and/or ended and where appurtenances are located.
- (3) Show the distance from the trunk water main center line to the parallel curb anywhere the distance changes.
- (4) Identify everything within two (2) feet of each side of the distribution main's right-of-way.
- (5) Identify and measure the distance between the trunk water main center line and MTA footing(s). Identify wherever the distance between the trunk water main and the footing changes.
- (6) Identify the trunk water main cover on the profile wherever it changes.
- (7) When sheeting or any types of sheeting members are left in place, provide type, thickness, depth, and cut off points of sheeting and members.

(B) SUBMISSION PROCESS

- (1) The name of the submittal(s) must include the date of the submission (YYYYMMDD), project ID, type of drawing(s) being transmitted, and borough(s) of the project.
 - (a) E.g., *20240822-BED-849 – Trunk Water Main As-builts Submission – Brooklyn*.
- (2) Upon completion of the work and as a condition precedent to obtaining the certificate for Substantial Completion under **Article 44** of the Contract, the Contractor will furnish to the City one (1) complete set of reproducible ink, record contract drawings on mylar; and one (1) electronic copy of the aforementioned contract drawings in PDF format. All drawings must conform to the standard size of ARCH D (24" x 36" (610 mm x 914 mm)), using a 1"=30' (1:360) horizontal and 1"=5' (1:60) vertical scale. All such record or as-built work must be as directed by the Engineer, and such drawings will become the property of the City. No direct payment will be made for this work, compensation for such work will be deemed included in other items.

GEOMETRY

1.6. GEOMETRY

To determine the definite horizontal and vertical alignment of the pipeline, the Contractor must excavate test pits along the line of the work and take all necessary field measurements to prepare the trunk main geometry including horizontal and vertical alignment and appurtenance locations that conform to the contract specifications, requirements of the contract drawings, and to field conditions. Alignment and appurtenance locations must be indicated by stationing, elevations, and deflection angles. Elevations must comply with the requirements of **Section 10.09(3)** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**. Legal and existing street widths, street alignment, grades, and all topographical and subsurface information from property line to property line identified and located must be shown on the geometry drawing. In addition, the relationship of the trunk main to significant field features (e.g., curbs, cross street centerline, subsurface structures, buildings lines, etc.) must be indicated by stationing and/or dimensioning. All reference points must be clearly documented so that they may be reestablished at any time.

The geometry must be submitted on ARCH D (24" x 36" (610 mm x 914 mm)) sheets with a horizontal scale of 1"=30' (1:360) and a vertical scale of 1"=5' (1:60). Each sheet must be stamped by a NYS Licensed Land Surveyor and/or Professional Engineer, and submitted for approval to the Engineer.

The Contractor must also submit for approval a pipe-laying schedule based on the approved geometry. After approval of the pipe-laying schedule, pipe fabrication drawings must be submitted for approval to the Engineer.

Payment for preparation of the geometry (including field measurements and test pits within the contract specified trench limits), the pipe-laying schedule, and the fabrication drawings must be deemed included in the various contract items. However, additional test pits, if ordered by the Engineer, will be paid for under item(s) labeled "ADDITIONAL EARTH EXCAVATION INCLUDING TEST PITS", and as described in **Section 73.31** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

1.7. CHANGES IN ALIGNMENT AND GRADE

The contract drawings give the alignment and grades of the pipes based upon the existing substructures as shown on these drawings, and the work will be laid out approximately as shown thereon. Corrections in alignment and grades may be necessary as the trench is excavated. Test pits must be done to minimize these corrections. Changes in the alignment or grades, from those shown on the contract drawings, and alterations of pipes, either in the shop or in the field, due to such changes in alignment or grade must be made by the Contractor at the Contractor's own expense, except that additional compensation will be made for bends other than those shown on the drawings, required to deflect the pipeline over, under, or around the City owned structures, as provided in the "Proposal for Bids".

1.8. CURVES AND SPECIALS

- (A) Wherever changes in line or grade of the pipes make angles necessary, they will be formed by cutting and beveling the ends of a sufficient number of courses to produce the desired total deflection or curvature. All bends less than two and a half degrees (2.5°) will be detailed with straight pipe having miter cuts at the ends, these cuts being made in the shop. As an alternate to the foregoing, and where appropriate, pipe may be deflected within pipe end in accordance with **Standard Drawing No. 35310-C-Y**. Closure or filler pieces of odd lengths must be furnished and delivered by the Contractor as required and approved. The Contractor will take careful measurements to determine the dimensions and curvature of all bends, closure pieces, and other specials required, and must be responsible for the accurate detailing and fabrication of same so that they will fit in the work. The shop drawings for all pipes, reducers, bends, and other specials must be submitted for approval of the Engineer before fabrication.

(B) Bends, reducers, tees, manifolds, and other special fittings must be detailed as follows:

- (1) Dimensions must be as specified in AWWA C208, except as modified below or in the Contract Drawings.
- (2) The angle subtended by any segment of a bend must not exceed fifteen degrees (15°); i.e., a miter cut shop welded joint may not allow a deflection greater than fifteen degrees (15°) per miter joint.
 - (a) Two miter cuts (i.e., one shop welded joint) are permissible for a maximum deflection of fifteen degrees (15°).
 - (b) Two shop welded joints, (i.e., one intermediate segment) are required for angles greater than fifteen degrees (15°), but not exceeding thirty degrees (30°).
 - (c) Three shop welded joints (i.e., two intermediate segments) are required for angles greater than thirty degrees (30°), but not exceeding forty-five degrees (45°).
 - (d) Four shop welded joints (i.e., three intermediate segments) are required for angles greater than forty-five degrees (45°), but not exceeding sixty degrees (60°).
 - (e) From the above, miter cuts for shop welded joints must not exceed seven and a half degrees (7.5°).
- (3) No circumferential girth seams may intersect each other.
- (4) The radius of any bend must not be less than two and a half (2.5) times the nominal diameter of the pipe.
- (5) The minimum length of a concentric or eccentric reducer must be seven (7) times the difference in nominal diameters of each end of the reducer (i.e., reducer length is seven (7) feet for every twelve (12) inch reduction in diameter), rounded to the nearest one (1) foot for diameter reductions of twelve (12) inches or more, and *rounded up* to the nearest three (3) inches for diameter reductions less than twelve (12) inches. The minimum difference in nominal diameters of each end of the reducer must be six (6) inches or as approved by the Engineer.

1.9. RESERVE PIECES

If called for by a note on the Contract Drawings, the Contractor must furnish, deliver, and have in reserve, in advance of the delivery of the other pipe, certain random lengths or closure pieces and bends to be used at locations where unexpected obstructions or other difficulties may arise, requiring their immediate use to avoid leaving the trench open at such locations for long periods, or otherwise delaying the completion of the pipeline. The number and dimensions of such closure pieces and bends to be furnished will be as given on the drawings.

Any pipe, bend, or special which is not called for in the schedules or on the contract drawings, or which is not required in the finished work, but which may have been delivered, at the finish of the contract, remain the property of the Contractor, or revert to the Contractor, and must be promptly removed by the Contractor from the site of the work.

Where a piece of pipe has been cut, the remaining section may be incorporated in the work by the Contractor, provided the length is not less than seven and a half (7 1/2) feet.

Sections less than 7 1/2 feet in length may be used, with the approval of the Engineer.

1.10. DIMENSIONS

Pipe fabricated for lap fillet welded field joints will be made with alternate inside and outside courses without reduction in the thickness or in the nominal diameter which is the inside diameter of the inside course; with a clearance between the laps of the pipe of 1/8" maximum and 1/16" minimum, measured on the diameter, and similar to that shown on **Standard Drawing No. 35310-C-Y** unless otherwise indicated on the contract drawings or specified.

Pipe for lap fillet welded field joints may also be fabricated by cold expanding one end to form a bell or by shop welding a steel sleeve on one end, the inside and remaining outside joints being made in the field as shown on **Standard Drawing No. 35310-C-Y**.

Pipe must be not less than thirty (30) feet long except where shorter lengths are required. All pipes must be manufactured by either spiralweld process using the double submerged arc welding method from steel coil, or the electric-fusion (arc)-welded straight-seam welding method using rolled plates (can pipe). Spiralweld is the default method and must be used where the quantity of pipe (straight pipe, bends, and specials) in a given size and thickness is more than can be produced from a single coil of steel. All longitudinal seams, splice seams, spiral seams, and shop girth seams must be butt-welded. The welding procedure chosen must be approved by the Engineer before any production starts.

When the can pipe manufacturing method is chosen, pipe 24" to 30" in diameter must be made with one (1) longitudinal seam. Pipe 36" to 48" in diameter may be made with two (2) longitudinal seams. Pipe 60" and larger may be made with three (3) longitudinal seams. On 36" to 48" diameter pipes, the plate must subtend a minimum arc of one hundred fifty degrees (150°). On pipes 60" in diameter and larger, the minimum arc must be one hundred degrees (100°).

1.11. CONNECTIONS, MANHOLES, AND REINFORCING RINGS

Manhole, blowoffs, hydrants, and lateral connection fittings (of the designs and materials specified and shown on the contract drawings) must be attached to the pipe at the general locations shown on the drawings and as shown on additional working drawings which may be furnished. The Contractor may increase the number of manholes beyond those shown on the drawings or ordered, but no additional payment will be allowed for such extra manholes. The Contractor must place additional temporary manholes and operate portable blowers through such manholes or pass holes as may be necessary to secure adequate ventilation within the pipeline and safeguard persons working therein. Additional manholes may be made by cutting an opening of approved size in the pipe, which is to be enclosed and made watertight by welding a steel plate, not less than the thickness of the pipe or 1/2" thick, whichever is greater, to the pipe. The details of all such additional manholes must be submitted for the approval of the Engineer before they are made. Reinforcing rings, bead bands, lugging bands, collars, and flanges must be provided and attached in an approved manner on all reducers and on all steel pipes where connections are made to cast iron pipe.

Steel specials must be firmly jointed to the pipe by welding, and required apertures through the pipe plates must be cut out neatly. While work is being done inside the pipe, the flanges of all manhole frames must be protected by a heavy disc of durable wood securely bolted in position. Between the flange and the wood disc, there must be a double layer of burlap saturated with heavy mineral grease.

1.12. DROP HOLES, SMALL PIPE CONNECTIONS, AND CORPORATION STOPS

NPS 2 drop holes must be provided in no less than every third outside pipe section and special and in alternate sections where "bell and spigot" welded joints are used. These drop holes must be located on the field top center line, approximately six (6) inches to thirteen (13) inches from one end of the pipe. These openings must be provided with forged steel saddles properly welded to the pipe, inside and outside. Openings in the saddles must be properly tapped and closed by solid forged steel plugs of approved design. Corporation stops installed for temporary connections must be removed and replaced with solid cast or forged steel or solid bronze plugs. Corporation stops, supplied by the Contractor and meeting the requirements of **Section 20.10 of the New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**, must be inserted in the steel pipe or in access manhole covers, as indicated on the contract drawings.

PAYMENT

1.13. PARTIAL PAYMENTS

As the basis for estimating the allowances for pipes and appurtenances prior to their installation, and for the purpose of making partial payments, the Contractor will submit to the Engineer material supplier's bills certified by the material supplier as to the amounts and quantities the Contractor charged. These certified amounts will be assumed as the latest prices.

If materials for which partial payments are made are not at the site or in the storage yard, on land owned by the City, the lease or leases to the land where such material is stored will be assigned by the Contractor to the City before partial payments will be made for such material.

The area of the storage yard must be sufficient to store the pipes without piling, and the yard must be of acceptable configuration, suitable for the storage and handling of pipes. The yard must be enclosed with an approved security fence with suitable hinges or rolling gates for trucks and, if ordered, separate hinged gates for people will be provided at approved locations. All gates must have locks sufficient to protect the stored material and the Engineer will be provided with keys. The Contractor will continuously provide the services of a security watchman, and the storage yard will be maintained in a neat and serviceable condition until permission is given for its discontinued use.

1.14. LENGTH OF MAINS FOR PAYMENT

For the purpose of payment, the length of trunk water mains furnished, delivered, and laid will be taken as measured along the axis of the pipe in place from the end of the existing pipe, irrespective of the number of joints, outlets, or closure pieces, but excluding the lengths of valves or other appurtenances for which separate payment is provided.

The length of each reducer will be taken as the centerline length of the reducer portion of the pipe section with the larger diameter taken as the diameter of the reducer. (See **Section 1.8(B)(5)**.)

For the purpose of payment, the length of each bend will be made by computing the length along the centerline of pipe from "point of curvature" to "point of tangency", using the radius of the bend and the true deflection central angle. The radius of bend must be in accordance with **Section 1.8(B)(4)** and must be a radius allowed by the Engineer to make the proper fittings.

No extra payment will be made for corporation stop connections, sampling outlet connections, and miter cuts on trunk water main pipe made up in the shop, but payment therefore will be included in the unit price per linear foot of trunk water main pipe.

Tangent pieces adjacent to bends will not be included in figuring the length of bends, but payment thereof will be made at the unit price for linear foot as straight pipe.

No extra payment will be made for any field cut, unused pipe, resulting from making necessary bevel field joints, due to unforeseen conditions (i.e., not due to the fault or omission of the Contractor). This unused pipe will become the property of the Contractor and must be hauled away from the field.

The caulking bands and sleeve closure pieces used to connect the new pipe to the existing pipe will be included for the purpose of payment in the price bid for item labeled "FURNISHING, DELIVERING AND INSTALLING PLATE STEEL OUTLETS ON STEEL PIPE, INCLUDING STEEL PIPE CLOSURE SLEEVE, CAULKING BANDS AND ACCESS MANHOLE OUTLET WITH COVER, NUTS AND BOLTS COMPLETE", and as described in **Section 60.25** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

1.15. NO EXTRA PAYMENT FOR FLANGES

No extra payment will be made for flanges including bolts and all accessories on straight pipe, reducers, bends, special castings, spool pieces, or piping adjacent to expansion joints, but payment thereof will be included in the unit price bid per linear foot as straight pipe or bends, if flanges are part of the straight pipe or bends.

No extra payment will be made for insulated flange joints indicated on the standard and contract drawings, but payment thereof will be deemed to be included in other items.

APPURTENANCES

1.16. BUTTERFLY VALVES

(A) DESCRIPTION

These specifications are applicable for installing butterfly valves with its appurtenances.

(B) MATERIALS

Butterfly valves, 24-inch through 72-inch, must comply with the requirements of **Section 20.03** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

(C) CONSTRUCTION METHODS

The Contractor must furnish, test, deliver, and install butterfly valves and actuators complete and ready for operation as specified herein, to the sizes and at the locations shown on the contract drawing and as directed by the Engineer. The butterfly valves together with all adjacent appurtenances (bypass, expansion joint, or coupling) will be housed in chambers which will be constructed by the Contractor in accordance with the following:

- (1) For 48-Inch and smaller Butterfly Valves - Applicable Standard Drawing.
- (2) For 60-Inch and larger Butterfly Valves - Applicable Contract Drawing.

(D) BY-PASS FOR BUTTERFLY VALVE

The Contractor must install the external by-pass as indicated on the Water Main Standard Drawings for the valve chamber for butterfly valves.

(E) PROVISION FOR PAYMENT

There will be no direct payment for various components, including six (6) inch (152-mm.) outlet and six (6) inch (152-mm.) flanged valve for installing complete by-pass valve arrangement, but payment for these components will be included in the unit price bid in the Schedule of Bid Prices for appropriate item labeled "FURNISHING, DELIVERING AND INSTALLING EXPANSION JOINT FOR BUTTERFLY VALVES INCLUDING 6-INCH BY-PASS OUTLET", or, for appropriate item labeled "FURNISHING, DELIVERING AND INSTALLING COUPLING". (See **Section 61.21** and **Section 60.27** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.)

(F) BUTTERFLY CONNECTION VALVE CHAMBERS

Split-sleeve coupling must meet the requirements of **Section 20.15** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**. The coupling must be installed as per manufacturer's recommendations and as directed by the Engineer for the following Water Main Standard Drawings, latest revisions:

- (1) **Standard Drawing No. 44162-W "Standard Chamber For 30" & 36" Butterfly Connection Valve On Steel Main"**
- (2) **Standard Drawing No. 44573-W "Standard Chamber For 48" Butterfly Connection Valve On Steel Main"**

1.17. EXPANSION JOINTS

Expansion joints will be installed at each 48" (1219-mm.), 36" (914-mm.), and 30" (762-mm.) line valve as per **Standard Drawing No. 48829-Z**. Payment will be made at the unit price bid in the Schedule of Bid Prices for appropriate items labeled "FURNISHING, DELIVERING AND INSTALLING 48-INCH EXPANSION JOINT FOR BUTTERFLY VALVES INCLUDING 6-INCH BY-PASS OUTLET", "FURNISHING, DELIVERING AND INSTALLING 36-INCH EXPANSION JOINT FOR BUTTERFLY VALVES INCLUDING 6-INCH BY-PASS OUTLET", or "FURNISHING, DELIVERING AND INSTALLING 30-INCH EXPANSION JOINT FOR BUTTERFLY VALVES INCLUDING 6-INCH BY-PASS OUTLET"; and will include the pipe with the six (6) inch (152-mm.) bypass outlet between the expansion joint and valve.

Expansion joints must be single-ended slip pipe with limit rods and must meet the requirements of AWWA C221. Slip pipe must be stainless steel. Contractor is to submit detailed shop drawings to the Engineer for approval.

All internal and external steel surfaces of each expansion joint, except the slip pipe, must be cleaned and sand blasted in full accordance with SSPC-SP5/NACE NO. 1 *White Metal Blast Cleaning*. Since these surfaces will be required to function satisfactorily in submerged service, the Contractor is specifically advised that Commercial or Near-White blast cleaning is not acceptable.

Immediately after cleaning, such surfaces will be primed and later finished with two coats of a National Sanitation Foundation (NSF) approved material specifically formulated for potable water usage and applied in accordance with the manufacturer's instructions. After assembly, defects in coating must be rectified.

1.18. FLOWMETERS

(A) DESCRIPTION

These specifications are applicable for installing flowmeters with its appurtenances.

(B) MATERIALS

- (1) Bi-directional flowmeters must be in compliance with **Section 20.12** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.
- (2) Uni-directional flowmeters must be in compliance with **Section 20.13** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

(C) CONSTRUCTION METHODS

The Contractor must furnish, test, deliver, and install flowmeters complete with all instrumentation, recorders, and appurtenances to the sizes and at the locations shown on the contract drawing and as directed by the Engineer.

The flowmeters together with all required appurtenances must be housed in chambers which will be constructed by the Contractor in accordance with the following:

- (1) For 48-Inch and smaller Flowmeters - Applicable Standard Drawing.
- (2) For 60-Inch and larger Flowmeters - Applicable Contract Drawing.

(D) MEASUREMENT

The quantity of flowmeters measured for payment will be the number of flowmeters of each size actually furnished, delivered, and installed by the Contractor and approved by the Engineer.

(E) PRICE TO COVER

- (1) The contract price for FURNISHING, DELIVERING, AND INSTALLING FLOWMETER TUBE AND APPURTENANCES, COMPLETE must be the unit price bid for each size of flowmeter furnished, delivered, and installed and must cover the cost of all labor, equipment, materials, plant, samples, tests, and insurance required and necessary to furnish, deliver, and install flowmeters in the manner specified herein. No separate or additional payment will be made for any costs associated with the work of furnishing, delivering, and installing flowmeters.
- (2) Payment for the chamber (concrete, reinforcing steel, structural steel, miscellaneous steel, manhole steps, and pipe-to-wall penetration seals), coupling, piping, and castings will be made to the Contractor under the appropriate bid items.

1.19. SPLIT-SLEEVE COUPLINGS

Split-sleeve couplings must meet the requirements of **Section 20.15** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

(NO TEXT ON THIS PAGE)

DIVISION 2. MATERIALS

(NO TEXT ON THIS PAGE)

MATERIAL REQUIREMENTS

2.1. MATERIAL GRADES

- (A) Pipe must be furnished to meet the requirements of one of the following standards, or equivalent API 5L X graded pipe:
- (1) Arc welded spiralwelded and straight seam pipe: ASTM A139, Grades C or D
 - (2) Resistance welded straight seam pipe 20" and under: ASTM A135, Grade B
 - (3) Seamless steel pipe for bypass piping, blowoffs, air cocks, etc.: ASTM A53, Type S, Grade A; or
ASTM A53, Type E, Grade B
- (B) All specimens and records must be furnished, and tests and analyses made, as provided in the above specifications. The Contractor must notify the Engineer in writing at least five (5) days in advance of the date of rolling, sampling, and testing of the plate. The Engineer will then determine whether the Department will be represented by an inspector during the fabrication and test, or will, in lieu thereof, accept certified copies of the mill tests and analyses. Duplicate samples must be furnished to the Engineer whenever required. Two (2) copies of mill test reports of all materials must be submitted to the Department Inspector.

2.2. MATERIAL THICKNESSES

Unless otherwise noted on the contract drawings, the nominal thickness of steel plates and coils for pipe and fittings which may be ordered by weight, must be as follows:

NOMINAL SIZE OF PIPE	NOMINAL THICKNESS	WEIGHT
24" to 36"	3/8"	15.3 Lb. per Sq. Ft.
	1/2"	20.4 Lb. per Sq. Ft.
48" to 72"	5/8"	25.5 Lb. per Sq. Ft.
	3/4"	30.6 Lb. per Sq. Ft.
	7/8"	35.7 Lb. per Sq. Ft.

For SI: Density of Steel = 490 lb./ft³ = 7.85 g/cm³

2.3. APPURTENANCES

(A) FLANGES AND GASKETS

- (1) Flanges for flanged joints, where called for or as indicated on the contract, must be standard steel hub-type or ring-type slip-on flanges, Class E, in accordance with AWWA C207. Flanges must be made from seamless forgings or cut as a single piece from steel plate, meeting the requirements of ASTM A181 Class 70 or ASTM A105, and must meet the requirements of AWWA C207.
- (2) Flanges must be flat faced (without projection or raised face) and must be welded front and back with continuous fillet weld size equal to the pipe wall thickness. Flanges must be spot faced or back faced at the rear; such facing will not reduce the minimum flange thickness by more than one-sixteenth (1/16) of an inch. The spot or back facing must be in accordance with MSS SP-6 *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings* and MSS SP-9 *Spot Facing for Bronze, Iron, and Steel Flanges*.
- (3) Dimensions of flanges must conform to hub-type or ring-type slip-on flanges, Class E, in accordance with AWWA C207, except for the bolt holes on insulated flanged joints. For insulated flange joints, the bolt hole diameters must be one-sixteenth (1/16) of an inch larger than the table values for flanges of pipes 16-inches diameter and less; and must be one-eighth (1/8) of an inch larger than the table values for flanges of pipes greater than sixteen (16) inches in diameter. For flanges for outlet connections, see **Standard Drawing No. 38226-Y-A**; for flanges for insulated flanged joints, see **Standard Drawing No. 46104-W**.
- (4) Blind flanges must conform to the Class E blind flange requirements of AWWA C207. Blind flanges must be flat faced.
- (5) Each flanged joint must be drilled and tapped with a one-quarter (1/4) inch hole for subsequent air testing as shown on **Standard Drawing No. 35310-C-Y**.
- (6) Center gaskets must be full-faced rubber with cotton cloth insert or epoxy/glass, one-eighth (1/8) of an inch thick, with bolt holes and bolt circle to match the *AWWA standard steel-ring flanges, Class E* for pipe 30-inches and larger in diameter.
- (7) Bolts, nuts, and washers for un-insulated joints must be carbon steel and must meet the requirements of ASTM A307, Grade B for bolts; ASTM A563, Grade A for nuts; and ASTM F844 for washers. The bolt head and nut must be of the heavy hex series for heavy hex bolts and for heavy hex nuts. Two washers per bolt (one on the inside head and the other on the nut) will be required. All bolts and nuts must be threaded in accordance with coarse-thread series (UNC), Class 2A and 2B fit respectively; and all surfaces must be free of mill scale.
- (8) For insulated joints, bolts and studs must be Type 304 stainless steel and meet the requirements of ASTM A193/A193M, Grade B8A, Class 1A, with a Class 2A thread fit. The thread bolt must be the heavy hex type in accordance with the dimensions of ASME B18.2.1. All bolts and studs up to one (1) inch diameter must be threaded with the coarse-thread series (UNC) and with the 8-pitch thread series (8UN) when one and one-eighth (1 1/8) inch and larger in diameter, except where tapped holes for flanged butterfly valves have UNC threads.
- (9) Nuts, for insulated joints, must be Type 303 stainless steel and meet the requirements of ASTM A194/A194M, Grade 8FA, Class 1A, with a thread fit of Class 2B and with a machined washer face. The nuts must also be the heavy hex head series in accordance with the dimensions of ASME B18.2.2 and must have thread pitch compatible to the mating bolt or stud. The threads must be cleaned and lubricated with a thread lubricant, such as molybdenum anti-seize paste lubricant, before packaging the nuts for shipment by the manufacturer, as approved by the Engineer.
- (10) Washers, for insulated joints, must be Type 304 stainless steel and comply with the chemical and physical requirements of ASTM A193/A193M, Grade B8A, Class 1A material. The required washer diameter that matches a particular size bolt must be as shown in **Standard Drawing No. 46104-W**.

- (11) All stainless steel threaded fasteners and washers will be cleaned free of all scale and must have a bright finish, and be passivated in accordance with approved procedures as given in ASTM A380. All stainless steel fasteners must be made up, during both shop and field assembly, with a thread lubricant. The thread lubricant must have properties that will prevent seizing and galling between the male and the female threads, reduce the torque required to tighten the fasteners, permit ready disassembly after many years of service in damp locations, and prevent contamination at the bearing surface of heads, nuts, and flanges. The thread lubricant must be readily applied by brushing or dipping, have no detrimental effect on the gaskets used, and must be a molybdenum anti-seize paste lubricant, as approved by the Engineer.
- (12) All bolts, carbon steel and stainless steel, must have a sufficient machined chamfer to ensure a sound starting thread. The Engineer must be notified in sufficient time prior to all tension tests and heat treatments so that arrangements can be made for QA personnel to witness the tension tests and heat treatments. If proper notification is not given, the tension tests and heat treatments may be disapproved. One test must be made for each diameter of each heat. Steps must be taken to ensure that heats are traceable. Notarized Material Test Reports (MTRs) from the manufacturers be submitted for review and approval by the Engineer in consultation with DEP-BWSO-ME&QA.
- (13) Certified test reports and mill certificates are required for each material heat incorporated under this work. One (1) chemical check is required for each heat of steel and two percent (2%) of the nuts; washers and bolts must be checked for dimensional compliance in the presence of the Engineer.
- (14) For all threaded fasteners, the Contractor must furnish a complete chemical analysis of each heat, made and certified by an approved laboratory, and must furnish a certified statement of the heat treatment procedure.

(B) FASTENERS

- (1) All flange bolts, nuts, and washers for insulated flange joints for valves, outlets, and tie-ins must be stainless steel as per **Section 2.3(A)**.
- (2) In addition, carbon steel flange bolts, nuts, and washers for all non-insulated flange joints must be as per **Section 2.3(A)** and must be coated with a fluoropolymer coating approved by DEP and meeting the 1,000-hour salt spray requirements of ASTM B117.

(C) OUTLET CONNECTIONS:

- (1) Outlet connections must be fabricated from carbon steel conforming to the requirements of **Section 2.1**. Flanges must conform to requirements in **Section 2.3.(A)**.
- (2) Before being coated, each flange, reinforcement collar, and manhole saddle must be hydrostatically air tested in accordance with **Section 3.12**.
- (3) Payment for these fittings will be on the weights indicated in the latest revision of **Standard Drawing No. 38226-Y-A**.

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DIVISION 3. SHOP FABRICATION

(NO TEXT ON THIS PAGE)

GENERAL SHOP FABRICATION REQUIREMENTS

3.1. GENERAL FABRICATION REQUIREMENTS

(A) HANDLING OF FABRICATED PIPE

- (1) During handling, loading, transportation, and unloading, more than ordinary care will be taken to prevent injury to the pipe. Loading and unloading must be done carefully, with each pipe at all times under perfect control. Under no condition must a pipe be dropped.
- (2) All dunnage, skids, and blocks must be padded with a layer of carpet and must be placed under each pipe in the shop, storage yard, and during transportation. The pipe must be securely wedged during transportation and elsewhere, as required. Stulling of the pipe ends is required with 4" x 4" wooden cross braces during transportation to the installation site. The braces must be placed such that they do not encroach or mar the coated internal surface of the pipe.
- (3) Pipe must be carried or lifted by the use of nylon slings or carpet padded forks to protect all exterior coating from damage. Coated pipe must be shipped with nylon tie-down straps located approximately over the stulling as required to maintain roundness of pipe to three-sixteenth (3/16) of an inch. In case any pipe is indented or deformed, it will be resumed to the proper shape if such repairs can be made acceptable; otherwise, it will be rejected and must be replaced with a new pipe. Wire rope slings and chain slings, padded or otherwise, will not be used to lift coated pipe.

(B) CITY INSPECTION OF PIPE FABRICATION

(1) INSPECTION FACILITIES

The fabricator of the pipe must have available for the City Inspector a desk and a locker for clothes for the City Inspector's exclusive use; and clean toilet and wash-up facilities must also be available.

(2) SAFETY EQUIPMENT FOR INSPECTOR

The fabricator must furnish the City Inspector, a "hard" hat, safety goggles, and such other safety equipment as may be necessary to protect the City Inspector from injury while performing the inspection functions on the premises.

(3) INSPECTION OF PIPE FABRICATION:

- (a) Not more than one (1) City Inspector will be assigned to the pipe fabrication for this Contract at any point in time. Under no conditions, e.g., if a portion of pipe fabrication is subcontracted resulting in two (2) or more pipe fabricators, will more than one (1) City Inspector be assigned to pipe fabrication for this contract.
- (b) The pipe fabrication will be done in a shop having adequate facilities to produce sufficient pipe per normal eight (8) hour daytime shift to enable the Contractor to fulfill the time requirement of this contract.
- (c) Pipe fabrication on Saturdays, Sundays, Holidays, or during overtime periods on weekdays is prohibited, unless specifically permitted by the Engineer.
- (d) Coating of pipe and specials must meet the requirements of **Section 4.5**.
- (e) The pipe fabricator must schedule all work in accordance with the above conditions.

3.2. FABRICATION TOLERANCES

- (A) All shearing, rolling, punching, fitting, welding, and other shop operations must be done in a shop having adequate facilities to produce sufficient pipe per daytime shift to enable the Contractor to fulfill the time requirements of this contract. Spiralwelded pipe must be fabricated from coiled steel stock, purchased to the appropriate ASTM standard as specified in **Section 2.1**, in automatic equipment that is capable of forming the proper thickness and strength pipe required by Contract requirements. Pipe fabricated from plate must be cold rolled to the proper curvature for its entire length. The variation of the radius of curvature from the specified radius must be held within the generally accepted limits of good workmanship.
- (B) There will be no flat area along the longitudinal seams; the plate will be crimped in a suitable press before rolling, or other special forming must be employed to meet this requirement.
- (C) All surfaces to be welded must be thoroughly freed from rust, scale, oils, and dirt before welding. Joint edges must be smooth, uniform, and free from defects that adversely affects proper welding. Surfaces and edges that are torch cut or air-arc gouged must be ground to remove slag and oxidation and be of the proper shape and contour for welding.
- (D) Longitudinal, spiral, coil splice, and circumferential shop joints must be double butt welded, with complete penetration by a method subject to the approval of the Engineer. Peripheral joints of pipe and special fittings must be accurately aligned and retained in position so that edges meet and surfaces coincide within one-eighth ($1/8$) of an inch. The welds must be central to the seam with complete penetration and, with automatic welding; the weld reinforcement will not extend more than $1/8$ " above the plate surface. The weld bead lying within the area of the contact surfaces of the field joint must be ground flush with the plate.
- (E) Circumferential (girth) seams must not be less than seven and a half ($7\ 1/2$) feet apart for straight pipe, unless otherwise approved or directed by the Engineer. The butt welding joints used in the shop for these seams will have the outside surface of the pipe coincide within one-sixteenth ($1/16$) of an inch, and the adjoining plates within one-eighth ($1/8$) of an inch, at the closest points.
- (F) The straightness of a 40-foot length of pipe must not deviate more than plus or minus one-half ($1/2$) of an inch from a straight line.
- (G) The tolerances will be as follows:
 - (1) The circumference will not be smaller than one-sixteenth ($1/16$) of an inch or greater than one-eighth ($1/8$) of an inch from the true circumference.
 - (2) Each of the diameters when measured on the zero (0), one hundred twenty (120), and two hundred forty (240) degree axes will not vary more than three-sixteenth ($3/16$) of an inch from the true diameter.
- (H) The length of a pipe must not deviate more than plus or minus two (2) inches from the specified length, and in accordance with AWWA C200.
- (I) The inside of the pipe must be prepared for the lining process, with cleaning of welds and weld spatter.

3.3. STAMPING, MARKING, AND SHIPPING OF PIPE

- (A) Before starting shop welding, each pipe and special will be given a *identifying piece number* stamped clearly on the inside of each end, approximately six (6) inches from each end and six (6) inches from the longitudinal or spiral seam. Where "bell and spigot" pipe is used, the identifying piece number will be stamped at the spigot end only, as near as possible to the invert level, and two (2) to four (4) inches from the edge.
- (B) Before leaving the shop, each length of pipe and special that conforms with the above specifications must be plainly marked in paint on the inside and near the end of the pipe and special, with the identifying piece number corresponding to that shown on the geometry drawing.
- (C) On the top center line of pipe, at the bolting up hole, an arrow will be painted on the outside of the pipe to indicate the direction of field assembly. Any curve or special, which cannot be completely fabricated in the shop, will be match marked to facilitate assembling in the field.
- (D) A detailed schedule in quadruplicate, on forms furnished by the Department, will be given to the Inspector for each shipment of pipe, specials, and appurtenances. These forms, numbered consecutively, will indicate each day's total shipment.
- (E) To assure roundness of pipe at joints, all pipe and fittings must be braced horizontally and vertically at both ends during storage and shipping. All pipe is to be rounded before bracing is installed.
- (F) Heat numbers on the steel plate used for fabrication must be painted on the plate in a position to be visible at the inside of the spigot end of the pipe after rolling.
- (G) Stamped-on identifying piece numbers will be encircled with a paint to spot location of the number.
- (H) The New York City Inspector must be furnished a report, daily giving:
 - (1) Heat numbers of plates used that day for making pipe or specials.
 - (2) Identifying piece numbers of all rolled pipe or specials:
 - (a) fabricated on that day,
 - (b) rounded and ring tested on that day,
 - (c) belled on that day,
 - (d) hydrostatically tested on that day, and
 - (e) lined, coated, and wrapped in that day.
 - (3) Identifying numbers of all straight pipe taken for making specials on that day.

SHOP WELDING REQUIREMENTS

3.4. WELDING CODES

All welding materials must comply with the ASME Boiler and Pressure Vessel Code (ASME BPVC), Section II – *Materials*, Part C – *Specifications for Welding Rods, Electrodes, and Filler Metals*. Materials and procedures will be such quality as will ensure thorough full penetration and sound weldments. Any welding rod, electrode, flux, or filler metal that shows undesirable properties during welding will be rejected.

The welding procedure specification (WPS), the procedure qualification record (PQR), and the welder/welding operator performance qualification tests (WPQ) in the shop or field will be indicated on the shop drawings as part of the general notes and must be approved by the Engineer before any production can proceed.

The welding procedures must be qualified in accordance with the standard qualification procedures as given in AWS B2.1, or ASME BPVC, Section IX.

Shop welding must be done by Submerged Arc Welding (SAW) where possible.

Manual welding must be done using the Shielded Metal Arc Welding (SMAW) or Flux Cored Arc Welding (FCAW) methods, except that FCAW must be gas-shielded for shop welding. Gas Tungsten Arc Welding (GTAW) will be allowed where specifically approved by the Engineer. Gas Metal Arc Welding (GMAW) is specifically not allowed.

3.5. ELECTRODES AND FILLER MATERIAL

Surfaces and edges to be welded must be free from scale, rust, and other foreign material. Edges that have been torch cut or air-arc gouged must be ground to remove slag and oxidation. All edges must have the proper bevel and miter configuration as by the Engineer, approved welding procedures, and ANSI/AWWA C206, except that the requirements of these specifications and applicable Bureau Contract and Standard Drawings must prevail in cases of conflict.

Electrodes used must be the brand and size indicated on the approved WPS. SMAW electrodes must be low hydrogen type and must be stored in accordance with the manufacturer's recommendations. Electrodes must remain in the manufacturer's sealed containers until ready for use. Once removed from the manufacturer's sealed container, electrodes must be used within eight (8) hours, placed in an electrode-heating oven heated to at least 250° Fahrenheit. Re-baking of electrodes in accordance with AWS D1.1 will be allowed, subject to prior written approval of DEP-BWSO/DDC-QA.

3.6. SHOP PROCEDURE QUALIFICATION REPORTS (PQR) AND WELD PROCEDURE SPECIFICATIONS (WPS)

All weld qualifications, weld procedures, and tests for shop fabrication must be witnessed by a Department inspector or, with prior written approval, a Department approved representative or laboratory. When a laboratory is performing this function, they will witness the weld procedures and perform the tests. The tests must be run and supervised by an AWS Certified Welding Inspector (CWI), provided at the Contractor's expense. A Weld Procedure Specification (WPS) is required for all welds. The cost of equipment, materials, and labor for all tests must be entirely borne by the Contractor.

3.7. SHOP WELDER PERFORMANCE QUALIFICATION (WPQ)

The Welder/Welding Operator Performance Qualification Test (WPQ) for manual shop welding (i.e., not SAW) must be a 3G or higher test in accordance with the Welding Procedure Specification (WPS) as specified in the ASME BPVC, Section IX, for fabricating carbon steel pipe. Each welder must be qualified for all positions in which the welder is welding. This WPS must reference the supporting Procedure Qualification Record (PQR). The format of the PQR, the WPS, and the WPQ are shown in ASME BPVC, Section IX. The test coupon must be large enough for two (2) tension specimens and four (4) guided bend test specimens, and the welder must be qualified if the tests are positive as for field joint welding. A chemical analysis of the weld filler metal must also be included for carbon, silicon, and manganese. There will be at least one (1) set of weld-test specimens taken of each size, grade, and wall thickness from work performed by each welding machine and each operator.

Welders and welding operators must have at least four (4) years of experience in welding ferrous metals. Time spent in a trade school leading to a relevant certification will count towards the required experience, credited at one-half of time spent (e.g., two (2) months in trade school to be credited as one (1) month of required experience), up to a maximum of one (1) year of required experience. In addition, all assigned welders must be qualified by the Department or by an approved laboratory prior to welding.

Welder qualifications (WPQ) must be re-certified by DDC-QA / DEP-BWSO as follows:

- (1) Every two (2) years.
- (2) Whenever there is a lapse of twelve (12) months or greater in the use of a DDC-QA / DEP-BWSO approved procedure (i.e., welding NYC water main work).
- (3) Whenever there is a lapse of six (6) months or greater in the use of the process on similar work (i.e., still using the welding process (SAW, FCAW, or SMAW) on the WPQ for similar work).
- (4) At the request of DDC-QA / DEP-BWSO, when there is a specific reason to question the welder's ability.

Re-certification of welders may require re-testing a WPQ, at the discretion of DDC-QA / DEP-BWSO.

Spiralweld welding operators are qualified for all thicknesses of pipe equal or thinner to the thickness tested on their WPQ.

The tests must be performed by the Department or a Department-approved testing laboratory, and a written report of each test specimen will be furnished to the Engineer. The tests must be run and supervised by an AWS Certified Welding Inspector (CWI), provided at the Contractor's expense. The cost of equipment, materials, and labor for all tests must be entirely borne by the Contractor.

SHOP TESTING

3.8. GENERAL

(A) GAUGING

The ends of all pipes will be measured with a circular gauge before leaving the shop, to ensure a proper fit and roundness at the joint, in accordance with **Section 3.2**.

3.9. COIL CHARPY V-NOTCH TESTING

Charpy V-Notch Impact Tests must be performed on every heat of pipe coil used for manufacturing spiralweld pipe and every heat of plate used for manufacturing can pipe. The samples must be removed from the end of the coil prior to welding. The samples must be machined in a set of three (3) transverse specimens in accordance with ASTM A370, and tested at the temperatures shown and meet the following minimum requirements:

<u>Test Temperature</u>	<u>Ft-lbs.</u>
30° F	25
0° F	15

When using subsize samples (i.e., pipe thickness of less than one-half inch) as specified in ASTM A673, the following minimum requirements must be met:

<u>Test Temperature</u>	<u>Ft-lbs.</u>
30° F	19
0° F	11

Should the average ft-lbs of the three (3) samples not meet the above requirements when tested at both temperatures, all the pipes manufactured from that heat will be rejected.

3.10. PRODUCTION PIPE TESTING

(A) SPIRALWELD PIPE PROCESS VERIFICATION TESTS

- (1) Qualification tests will be conducted prior to approval of the welding and coating processes. For the purpose of these tests, all equipment required for rolling, welding, testing, cleaning, coating, and wrapping pipe will be installed and ready for operation in the shop or shops where the pipe is fabricated, and coating applied.
- (2) A specimen of weld must be cut from each of three (3) pipes fabricated for approval of the spiralweld process. One (1) specimen must be cut from each longitudinal seam or spiral seam, and one (1) specimen from each circumferential butt-welded seam, with the opening left with rounded corners. The specimen may be cut from the end run of each pipe. In this case, the requirements for patch plates outlined in **Section 3.10(A)(5)** do not apply if the fabricator decides to discard the tested end run.
- (3) Each specimen must be large enough to furnish four (4) companion test pieces, two for bending and two for tension. Each of these test pieces must be at least fourteen (14) inches long, with weld running crosswise at its center, and must be machined to a width of one and one-half (1 1/2) inch. The weld reinforcement may be removed from each bending specimen. The welding process will be approved if the following requirements are met:
 - (a) The base metal tensile strength reached at failure must meet the minimum requirements of **Section 2.1** for the carbon steel material used to fabricate the pipe.
 - (b) The tensile stress at failures that occur in the welds or heat-affected zones must exceed the minimum specified tensile strength of the base material used, per AWWA C200. Tensile strength must be calculated as the ultimate load (pound-force) divided by the cross section of the test piece, measured adjacent to the weld.

- (c) Two (2) test pieces must show compliance to the *Bend-test specimens* requirements of AWWA C200, except that side-bends are not allowed.
 - (4) If any of the pieces fail in their respective test, whether tensile or bending, approval of the welding process will be withheld, and the pipe will not be accepted.
 - (5) If the welding process is approved, patch plates of the same material must be lap fillet welded inside and outside over the openings; and the three (3) lengths of pipe must be tested in the hydrostatic press, as provided in the hydrostatic test requirements below. Patch plates must lap openings by at least two (2) inches and welds tested by air pressure and soap solution. Welds must be 5/16" minimum. Flush patches, double butt-welded, may be used, provided the pipe or special fitting is hydrostatically tested thereafter in conformance with the hydrostatic test requirements below.
 - (6) Complete records of the results of the bending and tensile tests must be available at all times to the Engineer at the point of fabrication.
 - (7) These three lengths of pipe will be then sandblasted, lined, and coated by the mechanical means outlined in these specifications. The lining and coating process will be approved if the requirements of the specifications are met.
 - (8) The preliminary tests may be omitted with the approval of the Engineer, where the process has been previously approved and not changed in any respect in the interim.
 - (9) The fabricator's attention is called to the inspection provisions in the lining and coating specifications, when the lining and coating is done in a plant other than that in which fabrication and testing take place.
- (B) HYDROSTATIC TEST
- (1) Before being coated, each completed straight pipe, whether made via the spiralweld or can pipe process, must be hydrostatic tested per the *Hydrostatic testing of pipe* requirements of AWWA C200.
 - (2) The test pressure will be held for sufficient time to observe the weld seams. There must be no leaks.
 - (3) Cracks in the weld not more than three (3) inches in length may be repaired by welding, provided all the weld metal is removed at the sides of the crack and far enough beyond the end of the crack to ensure that sound metal has been reached. If any pipe under hydrostatic test develops more than one crack or a single crack more than three inches in length, the entire weld will be rejected.
 - (4) All repaired pipes must be subjected to the hydrostatic test specified above, and any completed pipe failing to meet the requirements on the third test will be rejected.
 - (5) A general sweating of the weld under the hydrostatic test will cause rejection of the complete pipe; peening, by hammer or other tools, will not be permitted. Hammer or similar marks on a weld, other than that authorized by the Engineer, will be sufficient grounds for rejection.
 - (6) Hydrostatic testing is not required for non-pressure pipes, such as carrier pipe.
- (C) PRODUCTION SPIRALWELD PIPE NON-DESTRUCTIVE TESTING
- Additional nondestructive testing will be required on all production spiralweld pipes as follows:
- (1) 100% of coil splice welds must be radiographic tested (RT) or ultrasonically tested (UT), meeting the *Testing Procedures* requirements of AWWA C200.
 - (2) A 4' length of spiralweld randomly selected out of every twenty (20) lengths of straight pipe produced must be nondestructive tested with ultrasonic testing (UT), meeting the *Testing Procedures* requirements of AWWA C200. Unacceptable indications identified during testing must be repaired and retested for acceptance by UT. Additional UT may be required by the Engineer if unacceptable indications are identified.

3.11. AIR TESTING

- (A) Air testing will be required on the following component welds:
- (1) Caulking bands as shown on **Standard Drawing 20731-Z-C**.
 - (2) Fillet welded lap joints as shown on **Standard Drawing 35310-C-Y**.
 - (3) Slip on flanged joints as shown on **Standard Drawing 35310-C-Y**.
 - (4) Pipe Sleeves and cover plates as shown on **Standard Drawing 35310-C-Y**.
 - (5) Outlet Saddles as shown on **Standard Drawing 38226-Y-A**.
 - (6) Manhole Saddles as shown on **Standard Drawing 38226-Y-A**.
- (B) Before being coated, the inside and outside of the pipe at the component welds must be painted with soap suds and tested with air at a pressure of 40 psi applied through the 1/4" tapped hole.
- (C) Any defect in the weld, indicated by air leak forming bubbles, must be repaired by chipping out a section of weld not less than one (1) inch either side of the defect and replacing the removed section. If, in the opinion of the Engineer, the number of defects disclosed by the test(s) are such as to indicate that the entire circumferential weld is defective, the entire weld must be chipped out and replaced. Caulking of welds will not be permitted. All joints, in which welding repairs have been made, must be retested. After testing, the 1/4" hole must be welded shut. After satisfactory completion and acceptance of each welded joint, the coating, electrical testing, and coating of the joints may be completed. Similarly, outlet connections and manholes welded in the field must be air tested.

3.12. SPECIAL AND FITTING PRODUCTION TESTING

100% of welds on fittings and special pipes must be nondestructive tested with ultrasonic testing (UT), meeting the *Testing Procedures* requirements of AWWA C200.

DIVISION 4. SHOP COATINGS AND LININGS

(NO TEXT ON THIS PAGE)

GENERAL SHOP COATING AND LINING REQUIREMENTS

4.1. LINING AND COATING SYSTEMS TO BE USED

- (A) All steel pipes and fittings furnished for use in the distribution system must be lined and coated unless specifically noted otherwise. The lining and coating systems to be used are as follows:
- (1) INTERIOR LINING
 - (a) All straight pipe, specials, and fittings, including interior of tees, outlets, and manholes in contact with drinking water: cement mortar meeting the requirements of AWWA C205, or as specified.
 - (b) Interior of bypass piping, blowoffs, and other 6" piping in contact with drinking water: NSF 61 approved epoxy meeting the requirements of AWWA C210, polyurethane meeting the requirements of AWWA C222, or as specified.
 - (c) Interior of carrier pipes and other pipes not in contact with drinking water: polyurethane meeting the requirements of AWWA C222, epoxy meeting the requirements of AWWA C210, or as specified.
 - (2) EXTERIOR COATING
 - (a) All straight pipe, specials, and fittings, where possible, either:
 - (i) Tape coating meeting the requirements of AWWA C214,
 - (ii) Polyurethane meeting the requirements of AWWA C222,
 - (iii) Or as specified.
 - (b) Outlets and portions of specials and fittings where the approved exterior coating system cannot be applied:
 - (i) Tape coating meeting the requirements of AWWA C209,
 - (ii) Heat-shrinkable coatings meeting the requirements of AWWA C216,
 - (iii) Or as specified.
 - (c) Flanges and exterior of manholes: NSF 61 approved epoxy meeting the requirements of AWWA C210, polyurethane meeting the requirements of AWWA C222, or as specified.
- (B) The system to use must be submitted to the Engineer for approval, and it will not be permitted to switch to other systems on the same Project. The same system must be used for field coatings.
- (C) If tape coating is used, the portion of straight pipes, specials, and fittings exposed within a chamber must be coated with NSF 61 approved epoxy meeting the requirements of AWWA C210, polyurethane meeting the requirements of AWWA C222, or as specified. If polyurethane coating meeting the requirements of C222 is used, it must be used on the interior of chambers as well. In either case, flanges must receive epoxy coating meeting the requirements of C210.
- (D) All linings and coatings must be applied per the manufacturer's recommendations.
- (E) Where used elsewhere in this specification, "coating" will refer to lining and coating, as appropriate.

4.2. COATING AND LINING SUBMITTALS

- (A) The following must be submitted for the Engineer's approval prior to application of any epoxy, polyurethane, tape, or heat-shrinkable coating or lining:
- (1) Material approval submittals:
 - (a) Manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.
 - (b) Technical and performance information that demonstrates compliance with the system performance and material requirements of the project.

- (c) Manufacturer's instructions and recommendations on surface preparation and application.
- (d) Colors available for each product (where applicable).
- (e) Compatibility of shop and field applied coatings (where applicable).
- (f) Safety Data Sheet (SDS) for each product.
- (g) Coating applicator's experience and qualifications, with list of references using the submitted product.
- (h) Documentation from the manufacturer certifying that the product meets the specified AWWA and/or NSF requirements.

4.3. COATING APPLICATOR'S QUALIFICATIONS

- (A) The coating applicator will be considered as qualified to perform work in the shop on straight pipe, special sections, welded joints, and appurtenances after the applicator has complied with the following:
 - (1) The applicator must have a suitable covered plant approved by the Engineer capable of cleaning, blasting, and coating steel pipe and appurtenances in accordance with AWWA Standards and AMPP Standards.
 - (2) The applicator must have been engaged in this type of work either as the head of the applicator's own business, or in a supervisory capacity with a concern doing this type of work for a period of at least five (5) years.
 - (3) The applicator must take a qualification test to be given by the Department. This test must consist of lining and coating a section of steel pipe in accordance with Department specifications. This section will be inspected and tested by the Department and, if found satisfactory, the applicator will be declared qualified.
 - (4) The applicator must employ experienced help for this work if the applicator is acting in the supervisory capacity and not doing the work himself.
 - (5) Should subsequent inspections reveal that the applicator is consistently doing work of an inferior nature, the applicator will be disqualified from all Department work.
- (B) The applicator must have suitable equipment, as recommended by the coating supplier, for application and quality control testing of the coating.
- (C) The applicator must certify that the manufacturer's recommendations and requirements will be followed.
- (D) The applicator must make available for the exclusive use of the City Inspector a desk and locker for clothes. Clean toilet and wash-up facilities must also be available.

4.4. MANUFACTURER'S REPRESENTATIVE

Whenever, in the opinion of the Engineer, the quality of the lining and/or coating operations has deteriorated so as to require excessive inspection and repairs, notwithstanding any other statement in these specifications, the applicator will be required to employ a qualified representative of the material manufacturer to supervise the applicator's operations.

4.5. COATING FACILITY

- (A) Coating of pipes and specials in a plant other than that in which fabrication and testing take place, will be permitted under the following conditions:
 - (1) No fabrication or testing of pipe under this contract is to be done unless an Inspector is at the fabricating plant.
 - (2) No coating of pipe under this contract is to be done unless an Inspector is at the coating plant.

4.6. REINSPECTION OF PIPE IN STORAGE

Pipe lying in storage after final inspection for a period of more than three (3) months before installation in the ground will be subject to reinspection, including the use of the electrical continuity (holiday) detector for determining any defects. Such pipe must be repaired, if required, as directed by the Engineer.

4.7. HANDLING AND DELIVERY

(A) DELIVERY:

- (1) Care must be exercised during loading, hauling, and unloading to prevent damage to any of the components of the completed pipe. Pipe and specials must be suitably braced, supported to provide sufficient bearing area to prevent damage to the coating, and tied to prevent shifting or distortion of the pipe during transportation.
- (2) Lined and coated pipe must at all times be handled with equipment such as stout, wide belt slings, and wide padded skids designed to prevent damage to the coating. Bare cables, chains, hooks, metal bars, or narrow skids will not be permitted to come in contact with the coating. All handling and hauling equipment must be approved by the Engineer before use.
- (3) When shipped by rail, all pipes must be carefully loaded on properly padded saddles or bolsters. All bearing surfaces and loading stakes must be properly padded with approved padding materials. Pipe sections must be separated so that they do not bear against each other, and the whole load must be securely fastened together to prevent movement in transit. When applicable to this type of pipe, the pipe must be loaded and tied into a unit load in strict accordance with the current loading rules of the Association of American Railroads.
- (4) In truck shipments, all pipes must be supported in wide cradles of suitable padded timbers with well secured wedge chock blocks, and all chains, cables, or other equipment used for fastening the load must be carefully padded. For smaller diameter pipes, sand or sawdust filled bags may be used instead of hollowed out timbers.
- (5) The purchaser must inspect the pipe and pipe protection on cars or trucks at destination, and if the pipe or pipe protection is found damaged, claim will be made against the carrier.

(B) PLASTIC END CAPS:

Plastic end caps must be securely fastened to pipe ends of completed pipe for protection of the lining. End caps must be maintained in place until time of installation.

EXTERIOR SHOP COATINGS

4.8. TAPE COATING

(A) MATERIALS

(1) PRIMER:

- (a) The primer must be supplied by the tape system manufacturer and must consist of a butyl rubber matrix in a solvent which will produce, without heat application, an effective bond between the pipe surface to be protected and the inner wrap tape. Primer must comply with all code and regulatory requirements regarding safety and environmental protection in effect at the location of use.

(2) COATING TAPES:

- (a) Inner wrap tape must be 20 mils thick, having a ratio of 11 mils of cross-linked butyl rubber adhesive mass bonded to 9 mils blend of high- and low-density polyethylene backing.
- (b) Outer wrap tapes (two (2) required) must each be 30 mils thick, having a ratio of 5 mils of pressure sensitive cross-linked butyl rubber adhesive mass bonded to 25 mils of high-density polyethylene backing. The first outer wrap tape must be colored black. The second outer wrap tape must be colored white.
- (c) Strip tape for longitudinal welds must be 25 to 35 mils thick, consisting of cross-linked butyl rubber adhesive mass bonded to a pliable low-density polyethylene backing.
- (d) Hand-wrapped tape for coating of fittings and field welds must be 35 mils thick, consisting of a soft cross-linked butyl rubber mass of high adhesive quality bonded to a blend of medium- and low-density polyethylene backing.

(3) PHYSICAL PROPERTIES:

- (a) The overall impact resistance for the pipe coating system must have a minimum average value of eighty-nine (89) in./lb. in accordance with ASTM G14. The total tape coating thickness for pipe sections must be eighty (80) mils minimum, and the total tape coating thickness for pipe fittings and field joints must be seventy (70) mils minimum. Other physical requirements of the tape coating system will equal or exceed the minimum physical property requirements tabulated in AWWA C209 and AWWA C214.

(B) APPLICATION

(1) PIPE COATING:

- (a) The pipe coating system will consist of pipe cleaning, surface blasting, primer application, strip taping longitudinal welded joints, and application of inner and outer wrap tapes.
- (b) The primer must be applied in a uniform thin film at an approximate coverage rate of 400 to 600 square ft. per gallon in accordance with the manufacturer's instructions. The primer should be thoroughly mixed and agitated as needed during application to prevent settling of solid material. The primer may be applied by spray or rug type action. The primer must coat the entire exterior pipe surface. The primer coat on the pipe should be uniform and free of floods, runs, sags, and drips. The primed surface should be free of any foreign substances such as sand, grease, oil, grit, and rust particles. The primer should be tacky to dry prior to the application of the inner wrap tape.
- (c) The application procedure for the tape coating must comply with the requirements of AWWA C214, except that an additional outer wrap tape must be applied to provide the required two (2) outer wrap tapes.
- (d) In the mechanical application of the coating tapes, the tensioning and dispensing machine will apply the inner and outer wraps to the rotating pipe in a spiral manner with a minimum one (1) inch overlap. The tape tension during application must be 8-10 pounds per inch of tape width for the inner wrap, and 13-15 pounds per inch of tape width for the outer wrap,

or as specified by the tape manufacturer. The maximum tension during application will not cause a narrowing of more than one-sixteenth (1/16) of an inch in the tape width.

(2) TAPE COATING FOR FITTINGS, FIELD JOINTS, AND REPAIRS:

- (a) Surface preparation, priming, and wrapping procedures for tape coating application of fittings, field joints, and repairs must comply with the applicable requirements of AWWA C209, AWWA C214, and the manufacturer's instructions. Pipe preparation must include blasting of fittings, and machine wire brushing of field joints and repairs. Following the cleaning and priming of these surfaces, they will be double-wrapped with hand-wrap tape applied with a hand-held pipe wrapping machine approved by the manufacturer.

(3) TESTS OF COATED PIPE:

- (a) After coating, each pipe section and fitting must be tested for thickness and for flaws in the coating system in accordance with the requirements of AWWA C209 and AWWA C214. After coating of welded joints in the field and the completion of any field repair work, these coated surfaces must also be tested for coating flaws in accordance with the requirements of AWWA C209 and AWWA C214. Any defects noted from the testing procedures must be repaired and the coating retested until satisfactory results are obtained.

(C) TESTING

- (1) The batch sampling and testing procedure, and basis of rejection for the tape coating system materials will be in accordance with the requirements of AWWA C209 and AWWA C214, except that all tests will be at the expense of the Contractor, in laboratories approved by the Engineer. The sampling selection will be done at the application plant as the tape coating materials are received. The number of samples taken will be based on the material quantities required as follows:
 - (a) One (1) batch sample and test series of primer, inner wrap tapes, and outer wrap tapes from the material required for tape coating five hundred (500) linear feet of straight pipe.
 - (b) One (1) batch sample and test series of handwrapped tape from the material required for tape coating fifty (50) field joints or pipe fittings.

4.9. POLYURETHANE COATING

(A) MATERIALS

This specification covers a polyurethane coating system for use as an external coating for pipe. The polyurethane must meet the requirements of and be applied in accordance with AWWA C222.

(B) APPLICATION

(1) GENERAL:

- (a) The Contractor must furnish all labor, equipment, and material required to prepare the surface and apply the coating in accordance with AWWA C222 and this specification.

(2) PREPARATION OF SURFACES:

- (a) Surfaces to be coated must be cleaned, including abrasive blast cleaning, in accordance with the *surface preparation* requirements of AWWA C222 and the coating manufacturer's recommendations and requirements.

(3) END PREPARATION OF PIPE, SPECIAL CONNECTIONS, AND APPURTENANCES:

- (a) Pipe section with butt or lapped joints to be joined by field welding will not be coated within 2 1/2 in. $\pm$ 1/2 in. (64 mm $\pm$ 13 mm) of the area to be welded. This requirement applies to both the inside and outside surfaces of the pipe. Coating material on the holdback, bevel, or band is not acceptable. When rubber gasketed joints or mechanical couplings are used, the coating may extend to the ends of the pipe; but the coating thickness on the pipe surfaces that receive rubber-sealing gaskets will not exceed what is recommended by the manufacturer of the coupling.

- (b) Nuts, bolts, and other items of mechanically threaded system parts used in conjunction with connections, couplings, and attachments that must be assembled and operated in the field will be left uncoated, except as shown on the approved drawings or specifications.
- (c) Spot faces on flanges and bolt holes must be coated with polyurethane.
- (d) Flange faces are to be uncoated and protected with a shop primer.

(C) TESTING

- (1) The Contractor must conduct quality control inspection of all of the coating as required by the *verification* requirements of AWWA C222. This includes testing for appearance defects, proper curing, dry film thickness, electrical continuity (holiday) inspection, and adhesion.
- (2) The Engineer reserves the right to witness and inspect the entire coating process per the *inspection* requirements of AWWA C222, unless waived in writing.

4.10. EPOXY COATING

(A) MATERIALS

- (1) This specification covers a 2-part epoxy coating system for use as an internal lining or external coating for pipe. The epoxy must meet the requirements of and be installed in accordance with AWWA C210.

(B) APPLICATION

(1) GENERAL:

- (a) The Contractor must furnish all labor, equipment, and material required, must prepare all surfaces to be coated, and must apply the NSF approved primer and either epoxy or polyurethane exterior surfaces to be coated.

(2) PREPARATION OF SURFACES:

- (a) Before blasting, all oil and grease on the surfaces of the metal must be removed thoroughly by flushing and wiping, using suitable solvents and clean rags. The use of dirty or oily rags or solvents will not be permitted. All other foreign matter not removable by blasting will be removed by suitable means. All metal surfaces must be thoroughly cleaned by blasting. Blasting-cleaning operations must remove all rust, scale, and other impurities from the surface, exposing base metal over all, presenting a grayish matte appearance, in accordance with SSPC-SP 10/NACE No. 2, with a minimum 2.5 mils surface profile. Blasted surfaces that rust before a priming coat has been applied must be cleaned of all rust by buffing or wire brushing or, at the discretion of the Engineer, will be reblasted. Adequate air separators will be used to remove effectively all oil and free moisture from the air-supply to the blaster.
- (b) After cleaning, the surfaces will be protected from and maintained free of all oil, grease, and dirt that might fall upon it from whatever source until it has received its final epoxy coat. Any surface showing pits or cracks after beginning of blasting will be set aside immediately, pending examination by the Inspector for approval, reconditioning, or rejection.
- (c) The use of epoxy that becomes fouled with foreign substances, has thickened through evaporation, or has begun to harden will not be permitted.
- (d) After application, the coatings must be uniform and free from floods, runs, sags, drips, holidays, or bare spots. Any bare spots or holidays must be recoated with an additional application of primer. All runs, sags, floods, or drips must be removed by scraping and cleaning and the cleaned area retouched, or, at the discretion of the Inspector, all such defects must be remedied by reblasting and repriming. Suitable measures will be taken to protect wet coatings from contact with rain, fog, mist, spray, dust, or other foreign matter until completely hardened.

(3) END PREPARATION OF PIPE, SPECIAL CONNECTIONS, AND APPURTENANCES:

- (a) Pipe section with butt or lapped joints to be joined by field welding will not be coated within 2 1/2 in. $\pm$ 1/2 in. (64 mm $\pm$ 13 mm) of the area to be welded. This requirement applies to both the inside and outside surfaces of the pipe. Coating material on the holdback, bevel, or band is not acceptable. When rubber gasketed joints or mechanical couplings are used, the coating may extend to the ends of the pipe; but the coating thickness on the pipe surfaces that receive rubber-sealing gaskets will not exceed what is recommended by the manufacturer of the coupling.
- (b) Nuts, bolts, and other items of mechanically threaded system parts used in conjunction with connections, couplings, and attachments that must be assembled and operated in the field will be left uncoated, except as shown on the approved drawings or specifications.
- (c) Spot faces on flanges and bolt holes must be coated with a thin coat of epoxy.
- (d) Flange faces are to be uncoated and protected with a shop primer.

(C) TESTING

- (1) The Contractor must conduct quality control inspection of all of the coating as required by the *verification* requirements of AWWA C210. This includes testing for appearance defects, proper curing, dry film thickness, electrical continuity (holiday) inspection, and adhesion.
- (2) The Engineer reserves the right to witness and inspect the entire coating process per the *inspection* requirements of AWWA C210, unless waived in writing.

4.11. HEAT-SHRINKABLE COATING

(A) MATERIALS

- (1) This section covers *heat-shrinkable polyolefin coatings* (otherwise known as *heat-shrinkable coatings* or *heat-shrink sleeves*) for coating of specials and fittings, and for repairs of other shop coatings. The heat-shrinkable coatings must meet the requirements of and be installed in accordance with AWWA C216.
- (2) Heat-shrinkable coatings may only be used for shop repair of coatings when approved in advance by the Engineer.

(B) APPLICATION

- (1) The Contractor must furnish all labor, equipment, and material required to prepare the surface and apply the heat-shrinkable coating in accordance with AWWA C216 and these specifications.
- (2) Surfaces for application must be cleaned, including solvent cleaning per SSPC-SP1, in accordance with the *surface preparation* requirements of AWWA C216 and the coating manufacturer's recommendations and requirements.

(C) TESTING

- (1) The Contractor must conduct quality control inspection of all of the coatings as required by the *quality control* requirements of AWWA C216. This includes testing for appearance defects, thickness, electrical continuity (holiday) inspection, and adhesion.
- (2) The Engineer reserves the right to witness and inspect the entire coating process per the *inspection* requirements of AWWA C216, unless waived in writing.

INTERIOR SHOP LININGS

4.12. CEMENT MORTAR LINING

(A) MATERIALS

- (1) This section covers cement mortar lining. The cement mortar lining must meet the requirements of and be installed in accordance with AWWA C205.
- (2) Cement mortar must be composed of cement, sand, and water, well mixed and of proper consistency to obtain a dense, homogeneous lining that will adhere firmly to the pipe surface. If an admixture is to be used by the Contractor, it will be subject to review and acceptance by the Engineer. Proportions of sand to cement must be not more than three (3) parts sand to one (1) part cement, by weight. The soluble chloride-ion (Cl-) content of the cement-mortar mix must not exceed 0.15 percent, expressed as a percentage of cement weight.
- (3) Cement, sand, water, curing compounds, and wire fabric or ribbon mesh reinforcing, must meet the requirements of AWWA C205.
- (4) The paint or other materials used to prevent the rusting of steel surfaces at hold backs of mortar lining or coating before pipe installation must be a quick-drying, corrosion resistant material with good bonding properties to steel and must dry tack-free and smooth within four (4) hours after application. The paint must be applied, without sags or runs, to a thickness that will not impair the clearances required for proper welding and installation of the joint. The paint material applied to the interior of pipe or fittings must be free from contaminants that may be harmful to the end user of the potable water.

(B) APPLICATION

(1) INSPECTION:

- (a) All materials furnished and work done will be subject to inspection. The Contractor must furnish, without additional cost to the purchased, reasonable assistance for the inspection of materials and workmanship. The Engineer or Inspector must, at all times, have access to all parts of the shop and works where such material is being manufactured or such work is being performed.

(2) CLEANING SURFACES:

- (a) All surfaces to be mortar lined must be cleaned to remove loose or other foreign matter that could interfere with the adherence of the cement mortar.

(3) THICKNESS:

- (a) Cement-mortar lining must be uniform in thickness, except at joints or other discontinuities in the pipe wall. Lining thickness must be as listed in AWWA C205 or as specified by the Engineer. Ends of lining must be left square and uniform with regard to the longitudinal axis of the pipe, and the lining holdback must be as specified by the Engineer for the type of joint required.

(4) EQUIPMENT:

- (a) **LINING:** Straight sections of pipe must be lined by use of a spinning machine specifically designed and built for the purpose of rotating the pipe section and centrifugally applying cement-mortar linings to the interior of steel pipe or by a method known to provide equivalent results.
- (b) **MIXING:** The mortar must be mixed in batches. The amount of cement and sand entering into each batch will be measured by weight. The quantity of water entering the mixer will be measured automatically by an adjustable device, or it will be otherwise measured to ensure that the correct quantity of water is being added.

(C) TESTING

(1) MORTAR LINING TEST CYLINDERS:

- (a) MORTAR TEST CYLINDERS: A set of at least two standard test cylinders, 6 in. in diameter by 12 in. in length, must be made each day from the mortar lining for each shift to satisfy the 7-day and 28-day strength quality control requirements of **Section 4.12(C)(1)(d)**. The mortar must be removed from the mix in accordance with ASTM C172, or samples may be prepared by omitting sufficient water from the production mix to obtain a 1-in. to 3-in. slump. Test cylinders, 6 in. x 12 in. (150 mm x 300 mm) or 4 in. x 8 in. (100 mm x 200 mm), must be made in conformance with ASTM C31. The test cylinders must be cured with the pipe at the same temperature and for the same total length of time. If the 7-day test attains 28-day test requirements, then the 28-day test need not be completed.
- (b) CENTRIFUGAL TEST CYLINDERS: Centrifugally spun test cylinders may be substituted for mortar test cylinders, at the option of the contractor. Test cylinders must be spun about their longitudinal axes in 6-in. diameter by 12-in long steel molds at a speed that will simulate the compaction of mortar in the lining to produce a spun cylinder wall thickness of at least 1-1/2 in. Then the cross-sectional area of the hollow cylinder will be used to determine its compressive strength. Damaged cylinders will not be tested.
- (c) TEST CYLINDERS: All test cylinders must be tested in accordance with ASTM C39, by an approved testing laboratory unless the contractor has approved testing facilities at the work site. In such an event, the tests will be made by the contractor. All cylinder tests will be performed by the contractor. All cylinder tests will be performed at the expense of the contractor. Certified test reports will be submitted by the contractor to the Engineer. Re-tests are the contractor's responsibility.
- (d) STRENGTH OF MORTAR LINING: Mortar test cylinders must attain a minimum compressive strength of 2,600 psi in 7 days or earlier, and 4,500 psi in 28 days or earlier. Pipe made with mortar lining that does not meet the strength requirements set forth herein will be subject to rejection. The average of any ten (10) consecutive strength tests of cylinders representing each mortar mix must be equal to or greater than the specified strength, and not more than 20 percent of the strength tests will have values less than the specified strength. No cylinder test result will be less than 80 percent of the specified strength.

(D) HANDLING OF COATED PIPE AND SPECIALS

(1) MANUFACTURE AND HANDLING:

- (a) During the entire period of the application of the lining and the curing thereof, the section must be carefully supported and handled to avoid damage to the mortar. If a pipe section must be moved, such operation must be done with every reasonable precaution to protect against damage. Any damaged portion of the lining will be cut out and replaced.

4.13. EPOXY LINING

Epoxy lining must comply with the requirements of **Section 4.10**.

4.14. POLYURETHANE LINING

Polyurethane lining will only be allowed for carrier pipes and similar applications not in contact with drinking water, or as specified. Where specified, polyurethane lining must comply with the requirements of **Section 4.9**.

(NO TEXT ON THIS PAGE)

DIVISION 5. FIELD CONSTRUCTION

(NO TEXT ON THIS PAGE)

GENERAL FIELD CONSTRUCTION REQUIREMENTS

5.1. WORK INCLUDED

The Contractor must lay, test, and make tight the line of pipe indicated on the drawings. The work of laying the pipe also includes the air test of pipe joints, the cleaning of the line in preparation for coating or covering, the final cleaning of the inside of the pipe, and the disinfection and filling of the line with clean water in preparation for placing it in service. Installation of pipe must meet the requirements of AWWA C604, except that the requirements of these specifications and applicable Standard Drawings must prevail in cases of conflict.

Any pipe, bends, or specials, which are not called for in the schedules or on the contract drawings, or which are not required in the finished work, but which may have been delivered, will, at the finish of the contract, remain the property of the Contractor or revert to the Contractor, and must be promptly removed by the Contractor from the site of the work.

5.2. SEQUENCE OF WORK

The sequence of work and shut-down periods must be approved by the Engineer in consultation with the NYC DEP Borough Distribution Engineer.

5.3. HANDLING PIPE AND SPECIALS

During loading, transportation, unloading, and lowering into the trench, more than ordinary care must be taken to prevent injury to the pipe or the coating. Pipe(s) and special(s) must be suspended on at least two (2) synthetic slings, each not less than six (6) inches in width, of ample strength to support the weight of the pipe or special, with each pipe or special under perfect control at all times. Additional slings must be used to suspend pipe longer than 40', subject to approval. Chain slings and wire rope slings regardless of padding are specifically prohibited for use in lifting coated pipes. Under no condition must material be dropped. Rolling of pipe on the ground or on skids will not be permitted. In case any pipe is indented or deformed, the pipe must be returned to the proper shape if such repairs can be made acceptably, otherwise the pipe will be rejected and must be replaced with a new pipe.

Pipe stored on the ground, awaiting installation in the trench, must be placed on burlap bags filled with sand to prevent damage to pipe coatings. Timbers must be used under the sandbags as necessary to ensure the pipe ends are off the ground.

At all times during erection of the pipeline, the Contractor must use every precaution to prevent damage to the protective coating on the pipe. No metal tools or heavy objects will be unnecessarily permitted to come in contact with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, and in case of such necessity the workman must wear shoes with rubber or composition soles and heels. This must apply to all surfaces, whether bare, primed, or coated. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the purchaser will be repaired as directed by the Engineer, by and at the expense of the Contractor.

5.4. TRENCH REQUIREMENTS

(A) TRENCH EXCAVATION

- (1) The pipe must be laid to accurate line and grade, and the excavation and backfill so performed that the pipe will be firmly imbedded. No timber blocking will be permitted for the purpose of maintaining line and grade; sandbags or other approved means may be used for this purpose. There must be at least a twelve (12) inch clear distance between the pipe and the sides of the trench.
- (2) Where the trench is in rock, no rock must project nearer than 6" to the bottom or 12" to the side of the pipe, and before laying, the bottom of the trench must be filled with clean earth thoroughly compacted to the level of the underside of the pipe.
- (3) Where the trench is in fresh fill or in soil of low bearing power, the pipe, where and as directed, must be laid on concrete cradles, supported on a continuous reinforced concrete mat or on

concrete pile caps which in turn will be supported on approved piles, where and as ordered by the Engineer.

- (4) Where the trench is in a material which, in the opinion of the Engineer, is not suitable to give a proper bed or support for the pipe, the Contractor must, where directed, excavate 6" below subgrade and fill to grade with not less than 3" of screened earth or sand thoroughly compacted to the underside of the pipe, or as directed by the Engineer.
- (5) Unless otherwise indicated on the plans or in the specifications, the length of trench which may be opened between the point where backfilling is completed and the point where excavation of the trench is commenced must, in general, not exceed five hundred (500) feet; this length, however, may be increased or reduced with the approval of the Engineer and in accordance with the Engineer's direction, depending upon the density of the population and the degree of the traffic congestion along the route of the pipeline, and the requirements of other City departments having jurisdiction of street permits, traffic, etc.
- (6) The lane adjacent to the trench must be used for trucks and equipment. The excavated material will not be placed on the streets except when permitted by the Engineer. No pipe or appurtenances will be left in the street overnight.

(B) TRENCH BRIDGING

- (1) All street intersections are to be kept clear of excavated or other material, and ample width of roadway left thereat for traffic.
- (2) At street intersection or across lines of traffic, and where ordered by the Engineer, the Contractor must construct temporary bridges across the trench, of adequate strength to carry 20-ton trucks. The bridges must consist of steel and/or timber, and detail drawings must be submitted to the Engineer for approval, before starting construction.
- (3) Where bridging is required for the full width of the street, the Contractor is to excavate approximately the full depth of trench for one-half of the street without interfering with traffic on the remaining half of the street. This work is to be done as expeditiously as possible, and the bridging is to be so placed that it will not be necessary to later interfere with the bridging supports in laying the pipe. Where only a portion of the width of the street is to be bridged, the Contractor is to carry on the Contractor's work in such a manner as may be directed by the Engineer, with a view of minimizing the interference with traffic on such street.
- (4) If the field conditions are such as, in the opinion of the Engineer, will justify the excavation of the trench across the full width of the street before any bridging is placed, such excavation may be made, provided the Contractor carries on the work of excavation continuously throughout the twenty-four hours until the excavation has been completed and at least one-half of street has been bridged.
- (5) When the pipe is being placed under a bridged roadway and the full width of the roadway is bridged, the Contractor may remove the bridging for one-half of the width of the roadway for the purpose of facilitating the placing of the pipe. The Contractor must replace the bridging so removed before the bridging on the remaining half of the roadway is disturbed, and must replace any disturbed bridging immediately after the work under it has been completed.

5.5. PIPE LAYING

(A) GENERAL LAYING REQUIREMENTS

- (1) **Inspection While Laying-Field Jointing:** After the trench has been excavated as required, the pipe, specials, gate valves, and other appurtenances must be delivered on the street and placed at once in the trench. Unless otherwise permitted, no pipe or appurtenances will be left on the street overnight and not more than six (6) hours before laying. When the pipe is on the filled sandbags, the pipe must be thoroughly cleaned and inspected, and the coating, if applied, must be removed from the surfaces that are to be in contact at the joints. This requirement, however, is not to be taken to apply to the priming solution used to protect the contact surfaces. When suspended above the trench, all abrasions of the coating which will be inaccessible after laying, must be

satisfactorily repaired as approved by the Engineer. The patch coating must be securely bonded and will lap the damaged portion at least four (4) inches. The pipe will then be lowered into place upon the subgrade excavated accurately to the desired elevation of the pipe and laid to the required line and grade without blocking. Pipe must not be dragged on the trench bottom in making joints. Wire rope slings and chain slings, regardless of padding, will not be used. After placing the pipe in the trench, special effort will be given to make up each field joint promptly and the Contractor must provide an adequate force of men and appliances to meet this stipulation. Every effort, including use of interior jacks and braces, must be made to keep the pipe round within the limits set in **Section 3.2**.

(B) FIELD JOINTING TO KEEP UP WITH PIPE LAYING

- (1) The work of making the field joints and outlet connections, etc., must keep up as closely as possible to that of the pipe laying gang so that, except where otherwise permitted, not more than five (5) joints will intervene between the last joint that is made and the pipe that is being laid.
- (2) If, at any time, the Engineer is of the opinion that the Contractor is not advancing the various portions of the work at a satisfactory rate, then the Contractor must, under the direction of the Engineer, temporarily suspend the pipe laying or any other portion of the work, to permit the other portions of the work to be advanced sufficiently to justify the resumption of the work suspended.
- (3) To minimize the effect of ambient temperature effects on expansion joints valve chambers during construction, joints immediately outside the chambers must be welded last before final backfilling. A "make-up" sleeved and welded joint may be introduced by the Contractor for this purpose at the Contractor's option.

(C) FLOATING OF PIPE

- (1) The Contractor must take every precaution against the floating of the pipe due to water flowing into the trench, or through flushing or puddling. In case of such floating, the Contractor must replace the pipe at the Contractor's own expense, making wholly good any injury or damage which may result. The responsibility for the movement of the pipe, due to water flowing into the trench, must rest entirely upon the Contractor and no claim will be made by or will be allowed to the Contractor for the expense of repairing the damage resulting therefrom, due to the deficiency, or alleged deficiency, in the capacity of the sewers or drains in the vicinity to carry off storm water flow, or for any other reason.

(D) MAINTAINING PIPE UNDER PRESSURE

- (1) In addition to the requirements for field testing stipulated herein, the Contractor must fill with water and maintain, under hydrostatic pressure, any portion or portions or the whole of the pipeline as frequently, and for such lengths of time, as may be directed by the Engineer, in order to keep the pipe as closely as practicable to a circular cross-section and unchangeable in shape when concrete is being placed about the pipe, when backfilling is being rammed or puddled and until it is acceptably consolidated, and when loads, other than from backfilling could, in the opinion of the Engineer, unduly distort the pipe; and the Contractor must use the available service pressure from water mains adjacent to the length to be filled, and the pressure must be maintained for the required time with only such slight fluctuations as may be approved. Any flanged joint which shows evidence of leakage after the introduction of hydrostatic pressure must be completely disassembled and reassembled at the Contractor's own cost and expense.

(E) DISINFECTION

- (1) When all construction work on a section has been completed, including all connections and appurtenances, cleaning, testing, and completing all necessary repairs to the coating, the Contractor, when and as directed by the Engineer, must disinfect the section as in accordance with **Subsection 60.12.3(E)** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

(F) CONCRETE BACKING AND VAULTS

- (1) The Contractor must place a suitable backing of concrete, reinforced, if and as directed, of such dimensions as may be ordered or shown on working plans to be furnished, at all bends and other locations in the pipeline, where, in the opinion of the Engineer, unbalanced pressures may exist or develop which will tend to cause movement in the pipeline, while the pipe is under normal or test pressure.
- (2) Vaults, manholes, and footings must be constructed around and under valves in accordance with the standard drawings, as specified.

(G) INSTALLATION OF PIPE INSIDE A CARRIER PIPE (SLIPLINING)

- (1) For pipe being installed via sliplining, the welding and completion of lining of pipe joints must keep up with the installation of pipe for safety concerns. Joints must be completed within one hundred (100) feet of the installation cofferdam.

5.6. BACKFILLING

Where there is a deficiency of good clean earth to fill the trench and/or where the excavated material consists of cinders or other deleterious material not suitable for backfill, the Contractor must backfill with acceptable backfill material and with such means and methods specified in **Section 40.06 - Backfilling** of the **New York City Department of Environmental Protection (NYC DEP) Standard Sewer and Water Main Specifications**.

FIELD WELDING REQUIREMENTS

5.7. WELDING CODES

All welding materials must comply with the ASME Boiler and Pressure Vessel Code (ASME BPVC), Section II – *Materials*, Part C – *Specifications for Welding Rods, Electrodes, and Filler Metals*. Materials and procedures will be of such quality as will ensure thorough full penetration and sound weldments. Any welding rod, electrode, flux, or filler metal that shows undesirable properties during welding will be rejected.

The welding procedure specification (WPS), the procedure qualification record (PQR), and the welder/welding operator performance qualification tests (WPQ) in the shop or field will be indicated on the shop drawings as part of the general notes and must be approved by the Engineer before any production can proceed.

The welding procedures must be qualified in accordance with the standard qualification procedures as given in AWS B2.1, or ASME BPVC, Section IX.

Manual welding must be done using the Shielded Metal Arc Welding (SMAW) or Flux Cored Arc Welding (FCAW) methods. FCAW must be the self-shielded type without the use of shielding gas. Gas Tungsten Arc Welding (GTAW) will be allowed where specifically approved by the Engineer. Gas Metal Arc Welding (GMAW) is specifically not allowed.

5.8. ELECTRODES AND FILLER MATERIAL

Surfaces and edges to be welded will be free from scale, rust, and other foreign material. Edges that have been torch cut or air-arc gouged must be ground to remove slag and oxidation. All edges must have the proper bevel and miter configuration as given by the Engineer, approved welding procedures, and ANSI/AWWA C206, except that the requirements of these specifications and applicable Bureau Contract and Standard Drawings must prevail in cases of conflict.

Electrodes used must be the brand and size indicated on the approved WPS. SMAW electrodes must be low hydrogen type and must be stored in accordance with the manufacturer's recommendations. Electrodes must remain in the manufacturer's sealed containers until ready for use. Once removed from the manufacturer's sealed container, electrodes must be used within eight (8) hours, placed in an electrode-heating oven heated to at least 250° Fahrenheit. Re-baking of electrodes in accordance with AWS D1.1 will be allowed, subject to prior written approval of DEP-BWSO/DDC-QA.

5.9. FIELD PROCEDURE QUALIFICATION REPORTS (PQR) AND WELD PROCEDURE SPECIFICATIONS (WPS)

For field fillet welds, a Procedure Qualification Report (PQR) is not required. If field groove welds are required, then a PQR prepared in accordance with and meeting the requirements of **Section 3.6** and approved by the Engineer is required.

A Weld Procedure Specification (WPS) is required for all welds. WPS' are not transferrable between companies, and the WPS must be for the entity employing the welder, i.e., a WPS from a general contractor cannot be used by a welding subcontractor. For joint ventures, a WPS from a joint venture member company may be used. WPS must be submitted to the Engineer for approval. New WPS must be prepared by an AWS Certified Welding Inspector (CWI), provided at the Contractor's expense.

A copy of the engineer approved Welding Procedure Specification must be kept at the field-welding site to allow the Engineer to monitor the field welding parameters and methods.

5.10. FIELD WELDER PERFORMANCE QUALIFICATION (WPQ)

The Welder/Welding Operator Performance Qualification Test (WPQ) for field joint welding must be performed as described below after the proposed welding procedures are approved by the Department. The qualifying test must be done on a pipe, in accordance with ASME BPVC Section IX, governing pressure pipe welding as specified in QW-461.9 and QW-202. The welding qualifications must be based on the type and position(s) of welds to be performed and sizes of pipe on the project; and will be according to QW-461.9 and QW-202. The minimum qualifying weld position is 5G or 6G. The welding procedures will be qualified only if two (2) tensile and four (4) guided-bend test specimens are prepared and tested as specified

in QW-150 and QW-160; and are accepted as specified in QW-153 and QW-163. The welder will be qualified if the test required as mentioned in QW-302 meets the requirements prescribed in QW-160. Each welder must be qualified for all positions in which the welder is welding.

Welders and welding operators must have at least four (4) years of experience in welding ferrous metals. Time spent in a trade school leading to a relevant certification will count towards the required experience, credited at one-half of time spent (e.g., two (2) months in trade school to be credited as one (1) month of required experience), up to a maximum of one (1) year of required experience. In addition, all assigned welders must be qualified by the Department or by an approved laboratory prior to welding.

Welder qualifications (WPQ) must be re-certified by DDC-QA / DEP-BWSO as follows:

- (1) Every two (2) years.
- (2) Whenever there is a lapse of twelve (12) months or greater in the use of a DDC-QA / DEP-BWSO approved procedure (i.e., welding NYC water main work).
- (3) Whenever there is a lapse of six (6) months or greater in the use of the process on similar work (i.e., still using the welding process (SAW, FCAW, or SMAW) on the WPQ for similar work).
- (4) At the request of DDC-QA / DEP-BWSO, when there is a specific reason to question the welder's ability.

Re-certification of welders may require re-testing a WPQ, at the discretion of DDC-QA / DEP-BWSO.

The tests must be made by the Department or a Department-approved testing laboratory, and a written report of each test specimen will be furnished to the Engineer. The tests must be run and supervised by an AWS Certified Welding Inspector (CWI), provided at the Contractor's expense. The cost of equipment, materials, and labor for all tests must be entirely borne by the Contractor.

5.11. FIELD FILLET WELDED LAP JOINTS

Field lap joints, unless otherwise indicated on contract drawings, must be a double lapped fillet welded all-around, as shown on **Standard Drawing No. 35310-C-Y**. A 15/16-inch diameter bolting up hole on the field top center line, 1/4 inch from each end of pipe or special, must be provided at each joint. For field-testing, a 1/4-inch NPT tapped hole must be provided. This hole will be located on the outside of the pipe, in the center of the lap, and approximately six (6) inches away from the bolting up hole. The tapped hole must be plugged before shipping.

Surfaces and edges to be welded must be free from scale, rust, and other foreign material. Edges that have been torch cut or air-arc gouged must be ground to remove slag and oxidation. All edges must have the proper bevel and miter configuration as given by the Engineer, approved welding procedures, and ANSI/AWWA C206, except that the requirements of these specifications and applicable Bureau Contract and Standard Drawings must prevail in cases of conflict.

Welds up to five-sixteenth (5/16) of an inch may be made in a single pass. If made in more than one (1) pass, all slag or flux remaining on any bead of welding must be removed before laying down the next successive bead. Any cracks or blowholes that appear on the surface of any bead of weld must be removed by chipping, grinding or gouging before depositing the next successive bead. There must be no under cutting of the base metal. All slag must be removed from finished welds and the welds must show workmanlike appearance, uniform section, and freedom from porosity and trapped slag.

All outlet connections and manholes must be welded with continuous, double fillet welds, as shown on **Standard Drawing No. 38226-Y-A**.

The holes used in aligning the pipe must be satisfactorily plug welded after the completion of each joint or must be closed by the insertion of a 7/8" diameter 7/8" long cold panhead rivet; and welded inside and outside.

FIELD TESTING

5.12. AIR TESTING OF WELDED JOINTS

- (A) Air testing will be required on the following component welds:
 - (1) Caulking bands as shown on **Standard Drawing No. 20731-Z-C**.
 - (2) Fillet welded lap joints as shown on **Standard Drawing No. 35310-C-Y**.
 - (3) Slip on flanged joints as shown on **Standard Drawing No. 35310-C-Y**.
 - (4) Pipe Sleeves and cover plates as shown on **Standard Drawing No. 35310-C-Y**.
 - (5) Outlet Saddles as shown on **Standard Drawing No. 38226-Y-A**.
 - (6) Manhole Saddles as shown on **Standard Drawing No. 38226-Y-A**.
- (B) Before being coated, the inside and outside of the pipe at the component welds must be painted with soap suds and tested with air at a pressure of 40 psi applied through the 1/4" tapped hole.
- (C) Any defect in the weld, indicated by air leak forming bubbles, must be repaired by chipping out a section of weld not less than one (1) inch either side of the defect and replacing the removed section. If, in the opinion of the Engineer, the number of defects disclosed by the test are such as to indicate that the entire circumferential weld is defective, the entire weld must be chipped out and replaced. Caulking of welds will not be permitted. All joints, in which welding repairs have been made, must be retested. After testing, the 1/4" hole must be welded shut. After satisfactory completion and acceptance of each welded joint, the coating, electrical testing, and coating of the joints may be completed. Similarly, outlet connections and manholes welded in the field must be air tested.

(NO TEXT ON THIS PAGE)

DIVISION 6. FIELD COATINGS AND LININGS

(NO TEXT ON THIS PAGE)

GENERAL FIELD COATING AND LINING REQUIREMENTS

6.1. LINING AND COATING SYSTEMS TO BE USED

For determining the coating and lining systems to be used, the requirements of **Section 4.1** must be followed.

6.2. PROTECTION OF PIPE COATING

The Contractor must at all times take every precaution to prevent injury to the coating of the pipe and appurtenances by workmen or trespassers. During the laying and jointing of the pipe, or at any other time while it is exposed, no person will be permitted to walk on or in the pipe wearing boots or shoes with hobnails or other attachments that will injure the coating. Dropping of tools and other materials on the pipe, dragging of heavy objects over them, and other acts that would mar the coating must be prevented. The ends of completely coated pipes in the storage yard, unless otherwise permitted, will be stopped by an approved head or barrier of wood or metal with apertures not more than four (4) inches wide. Unless pipes delivered on the street from the storage yard are to be immediately placed in the trench, the ends will be similarly protected, and the heads or barriers will not be removed until the pipes are about to be laid. Each day at the close of work, and when laying is not in progress, the exposed ends of the pipe in the trench will also be protected in this way. Ends of pipe, if any, when it becomes necessary to cover with earth before making connection to adjacent piping, must be closed by suitable timber bulkheads before the trench is backfilled.

6.3. COMPLETION OF FIELD JOINTS

After satisfactory completion and acceptance of the field test, the Contractor must remove any water from the section and must clean all of the interior surface. All abrasions and other damage to interior lining must be cleaned, dried, and repaired. The coating will then be completed at all field joints and at all jointed appurtenances, primed and coated on the exterior and the interior, as hereafter specified, except that the coating may be applied by hand. Coating will be bonded firmly and smoothly, to lap adjacent layers by at least one (1) inch, or as required for by the coating manufacturer's written instructions.

After completion of coating, the section of trench over the field joint must be backfilled as hereafter specified.

6.4. HANDLING OF COATED PIPE AND SPECIALS

(A) TRANSPORTING AND HANDLING LINED AND COATED PIPE:

- (1) Lined and coated pipe must at all times be handled with equipment such as stout, wide belt slings, and wide padded skids designed to prevent damage to the coating. Bare cables, chains, hooks, metal bars, or narrow skids will not be permitted to come in contact with the coating. All handling and hauling equipment must be approved by the Engineer before use.
- (2) When shipped by rail, all pipes must be carefully loaded on properly padded saddles or bolsters. All bearing surfaces and loading stakes must be properly padded with approved padding materials. Pipe sections must be separated so that they do not bear against each other, and the whole load must be securely fastened together to prevent movement in transit. When applicable to this type of pipe, the pipe must be loaded and tied into a unit load in strict accordance with the current loading rules of the Association of American Railroads.
- (3) In truck shipments, all pipes will be supported in wide cradles of suitable padded timbers hollowed out on the supporting surface to fit the curvature of pipe, and all chains, cables, or other equipment used for fastening the load must be carefully padded. For smaller diameter pipes, sand or sawdust filled bags may be used instead of hollowed out timbers.
- (4) The purchaser must inspect the pipe and pipe protection on cars or trucks at destination, and if the pipe or pipe protection is found damaged, claim will be made against the carrier.

(B) HANDLING LINED AND COATED PIPE IN FIELD OR AT TRENCH:

- (1) Pipe must be stored along the trench side, supported on wooden timbers placed under the uncoated ends to hold the pipe off the ground.

- (2) Pipe must be hoisted from the trench side to the trench by means of a wide belt sling. Chains or cables, no matter how well padded, tongs or other equipment likely to cause damage to the coating will not be permitted. Dragging or skidding the pipe will not be permitted. The Contractor will allow inspection of the coating on the underside of the pipe while suspended from the sling. Any damage must be repaired before lowering the pipe into the trench.
- (3) Where the trench traverses over rocky ground or ground containing hard objects that would penetrate the protective coating, a layer of screened earth or sand not less than three (3) inches in thickness must be placed in the bottom of the trench prior to installation of pipe, or as otherwise specified or directed by the Engineer.
- (4) At all times during erection of the pipeline, the Contractor must use every precaution to prevent damage to the protective coating on the pipe. No metal tools or heavy objects will be unnecessarily permitted to come in contact with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, and in case of such necessity the workman must wear shoes with rubber or composition soles and heels. This must apply to all surfaces, whether bare, primed, or coated. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the purchaser must be repaired as directed by the Engineer, by and at the expense of the Contractor.

6.5. ELECTRICAL CONTINUITY (HOLIDAY) TESTING AND THICKNESS INSPECTION

- (A) All coatings and linings of installed pipes, fittings, and joints must be inspected for defects by visual inspection and by an electrical continuity (holiday) detector. All appearance defects, if required, and detected holidays must be repaired, as directed by the Engineer. Repaired areas must be reinspected by an electrical continuity (holiday) detector. The final coated and lined pipes, fittings, or joints must be holiday free.
- (B) ELECTRICAL CONTINUITY (HOLIDAY) DETECTOR
 - (1) The detector must be portable, have an adjustable voltage, and be capable of applying a high-voltage pulse. A high-voltage voltmeter, either integral to the detector or a separate device, must have a maximum accuracy of ± 0.2 kV.
 - (2) The detector must be properly grounded throughout all inspections.
 - (3) The detector must physically traverse across all inspection areas. The maximum single pass traverse rate of the detector must be the lesser of one (1) ft/s or manufacturer's recommendation. Overlapping passes of the inspection areas to ensure 100% coverage are permitted.
- (C) Unless otherwise specified, the electrical continuity (holiday) inspection for each coating/lining type must be conducted in accordance with the applicable AWWA standard after the coating/lining has been properly applied.
 - (1) Electrical continuity (holiday) inspection for tape coating must be conducted in accordance with AWWA C209 and AWWA C214.
 - (2) Electrical continuity (holiday) inspection for polyurethane coating/lining must be conducted in accordance with AWWA C222.
 - (3) Electrical continuity (holiday) inspection for epoxy coating/lining must be conducted in accordance with AWWA C210.
 - (4) Electrical continuity (holiday) inspection for heat-shrinkable coating must be conducted in accordance with AWWA C216.
- (D) THICKNESS INSPECTION GAUGE AND GAUGE READINGS
 - (1) The thickness gauge must be either a magnetic pull-off gauge with an analog dial (scale) in the gauge, or an electronic gauge. The thickness gauge must measure all thicknesses non-destructively. A *Certificate of Calibration* for the thickness gauge, as described in ASTM D7091, must be submitted.

- (2) Gauge accuracy must be verified at a minimum of the beginning and end of each work shift according to the procedures described in ASTM D7091. Gauge accuracy must also be verified if the gauge is dropped, or the gauge is suspected of giving erroneous readings. Gauge accuracy must be verified during measurement acquisition (e.g., hourly) when a large number of measurements are being obtained. Damaged gauges are prohibited from conducting thickness inspections.
 - (a) A magnetic thickness gauge must have a maximum tolerance of $\pm (0.1 \text{ mils} + 10\% \text{ of gauge reading})$ or as specified by gauge manufacturer, and a maximum accuracy of 10% of the gauge reading.
 - (b) The *base metal reading* (BMR), used for verifying the accuracy of the magnetic thickness gauge, must be reported.
 - (c) An electronic thickness gauge must have a maximum tolerance of $\pm (1.00 \text{ mil} + 3.0\% \text{ of gauge reading})$ or as specified by gauge manufacturer, and a maximum accuracy of 3.0% of the gauge reading.
 - (d) For SI: $25.4 \mu\text{m} = 1 \text{ mil}$.
- (3) Gauge readings must be conducted per SSPC-PA2 procedures and in accordance with the AWWA standard(s) for the specified coating/lining. No single gauge reading will be less than the specified minimum thickness or, if required, greater than the maximum specified thickness. A value lower than the specified minimum will constitute failure to meet the requirement.
- (4) Unless otherwise specified *more stringently* in the AWWA standard(s) for the specified coating/lining, the maximum allowable deviation of any single gauge reading, (otherwise known as the "thickness restriction level" or "thickness tolerance"), is $\pm 20\%$ of the specified value(s) (i.e., 80% of the specified minimum and, if specified, 120% of the specified maximum; otherwise known as "thickness restriction level 3").
- (E) Unless otherwise specified in this specification for the specified coating/lining, the minimum dry film thickness of the specified coating/lining and, if required, the maximum dry film thickness, and the quantity of coats of the specified coating/lining must be as specified in the AWWA standard.
 - (1) For the purpose of final acceptance of the total dry film thickness, the thickness of all coating layers must be no less than the minimum specified thickness and no greater than the maximum specified thickness; and the thickness of all lining layers must be no less than the minimum specified thickness and no greater than the maximum specified thickness.
 - (2) Tape coating thicknesses for inner wrap coating, outer wrap coating, and strip tape for longitudinal welds, and total tape coating thickness must be in accordance with **Section 4.8**.
- (F) Unless otherwise specified in the AWWA standard(s) or this specification for the specified coating/lining, thickness inspection must be conducted in accordance with the AWWA standard after the coating/lining has been properly applied.
 - (1) Thickness inspection for tape coating must be conducted in accordance with SSPC-PA2, at thickness restriction level 3 (80% of the specified minimum and, if specified, 120% of the specified maximum), to ensure compliance with AWWA C214.
 - (2) Thickness inspection for polyurethane coating/lining must be conducted in accordance with SSPC-PA2, at thickness restriction level 1 (minimum as specified and, if specified, maximum as specified), to ensure compliance with AWWA C222.
 - (3) Thickness inspection for epoxy coating/lining must be conducted in accordance with SSPC-PA2, at thickness restriction level 2 (minimum as specified and, if specified, 120% of the specified maximum), to ensure compliance with AWWA C210.
 - (4) Thickness inspection for cement mortar lining must be conducted in accordance with AWWA C205, at the thickness tolerances specified therein.
- (G) Thickness inspection may occur concurrent with electrical continuity (holiday) inspection provided that neither inspection interferes with the other.

EXTERIOR FIELD COATINGS

6.6. FIELD COATING SYSTEMS TO BE USED

The field coating systems to be used must be selected in accordance with **Section 4.1**.

6.7. TAPE COATING

Tape field coatings must meet the requirements for hand-wrapped tape coating installed per AWWA C209 in **Section 4.8**.

6.8. EPOXY COATING

Epoxy field coatings must meet the requirements of shop epoxy coatings in **Section 4.10**.

6.9. HEAT-SHRINKABLE COATING

Heat-shrinkable field coatings must meet the requirements of shop heat-shrinkable coatings in **Section 4.11**.

INTERIOR FIELD LININGS

6.10. FIELD LINING SYSTEMS TO BE USED

The field lining systems to be used must be selected in accordance with **Section 4.1**.

6.11. CEMENT MORTAR LINING

- (A) All field joints between pipes with cement mortar lining must have field cement mortar joints applied per AWWA C205.
- (B) Field cement mortar lining will not be permitted on entire pieces of pipe. Field cement mortar lining work is limited to joints and repairs approved in advance by the Engineer.

6.12. EPOXY LINING

Where specified, epoxy lining must meet the requirements of shop epoxy coating in **Section 4.10**.

6.13. POLYURETHANE LINING

- (A) Polyurethane lining in the field will not be allowed.
- (B) Repairs to polyurethane lining on carrier pipes must be repaired in the field and meet the *polyurethane repair* requirements of AWWA C222.

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DIVISION 7. CORROSION CONTROL

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GENERAL CATHODIC PROTECTION REQUIREMENTS

7.1. INTRODUCTION

The following specification is a general guideline to be followed for the design, installation, and testing of cathodic protection (CP) systems. Corrosion control is often site specific and several of the guidelines listed here may not apply in every case. There may be occasion when the Contractor will be directed to perform a task not listed in this specification, or to omit a specified task. Amendments to this specification will be made in writing on an individual contract basis, with the full agreement of the Contractor's Corrosion Specialist and the Engineer.

7.2. INTENT AND SCOPE OF WORK

- (A) The Contractor and the Contractor's Corrosion Specialist must furnish all design, labor, equipment, and materials, and install and test the cathodic protection system (CPS) as required in accordance with the contract specifications, ordered or approved. A complete corrosion control system for the water main(s) must be installed under this contract. The corrosion control system must be designed to assure protection, based on prevailing conditions for a minimum of fifty (50) years. The Contractor must also provide all labor necessary to test the corrosion control system, in part or as a whole.
- (B) The Contractor must employ the services of a Corrosion Specialist certified by the Association for Materials Protection and Performance (AMPP) (formerly the National Association of Corrosion Engineers [NACE] and the Society for Protective Coatings [SSPC]) and approved by the Engineer in consultation with DEP-BWSO-ME&QA. The Corrosion Specialist must design the CPS in accordance with the general requirements of NACE SP0169 latest edition and this specification, amended as required.
- (C) The Corrosion Specialist or an approved AMPP Corrosion Technologist in the employment of the Corrosion Specialist must supervise the installation and testing of the CPS.
- (D) All CP work must be done under the surveillance of the Engineer in consultation with DEP-BWSO-ME&QA. No CPS work will be performed without a minimum of three (3) days prior notification to the Engineer. Failure to provide this notice before any testing, surveying, or installation work may cause the rejection of all work performed or may result in denial of approval to work on future contracts.
- (E) The Contractor will be responsible for notifying the Corrosion Specialist of all changes in geometry, design, and materials, regardless of whether the changes are the responsibility of the Contractor or the City.

7.3. CORROSION SPECIALIST'S RESPONSIBILITY

- (A) The Corrosion Specialist recommended by the Contractor and approved by the Engineer must supply the following information:
 - (1) Certification as an AMPP Corrosion Specialist.
 - (2) Certification for supervisors as AMPP Corrosion Technologists or higher.
 - (3) Evidence of responsible design for at least two projects of equivalent size and conditions.
 - (4) References from clients serviced within the past five (5) years.
 - (5) In addition, the Corrosion Specialist / Corrosion Engineering Firm must meet all other requirements for a subcontractor as set forth in the general specifications.
- (B) The Corrosion Specialist will be responsible for all design, testing, installation, and survey work done regarding the CPS design, installation, interim testing, final testing, and any repair required to make the system acceptable to the Engineer in consultation with DEP-BWSO-ME&QA. A system must be established to record all work done relating to this system. This includes, but is not limited to:
 - (1) All preliminary work, such as soil surveys, pipe-to-soil (P/S) surveys of existing structures, stray current surveys and any other work needed to compile information for the proposed CPS.
 - (2) All anode groundbed (GB) installations, lead wire connections, and test box assemblies.

- (3) Interim and final testing of the system or completed sections. This includes, but is not limited to, testing of isolating joints (IJ), ON and OFF P/S potentials, and stray current effects. All CP testing reports must be submitted to DEP-BWSO-ME&QA for review and acceptance.
- (4) Stray current surveys performed during and after installation.
- (5) Electrical continuity (holiday) testing of the installed pipeline.
- (6) Damage to or conditions surrounding the pipeline affecting CP and remedial measures taken.
- (7) Isolation of the pipeline from other existing metallic structures, within the contract limits.
- (8) As-built sketches, showing anode and test station locations; locations must be legible. There must be a maximum of three (3) test station details per 8½-inch by 11-inch sketch. Locations will be given by distances from street curb intersection or by street address if applicable.
- (C) The Corrosion Specialist will be responsible for reviewing all data collected in the field and forwarding signed copies of the information to the Engineer.
- (D) The Corrosion Specialist must serve as a coordinator with existing utilities and services with influence within the limits of the contract, or whose facilities may be affected by the installation. These include, but are not limited to, gas, electric, telephone, cable, other utility companies, railroads/railways, MTA New York City Transit (NYCT), etc.
- (E) The Corrosion Specialist must give the Contractor, Engineer, and DEP-BWSO-ME&QA three (3) days advance notification of all planned activity regarding the CPS. A cancellation notice of any work scheduled must be given by 4:00 PM on the previous business day. Costs incurred by the City as a result of a no-show by the Corrosion Specialist will be the responsibility of the Contractor.

7.4. DESIGN PARAMETERS

- (A) The Corrosion Specialist must design the system to function effectively under prevailing conditions for a minimum of fifty (50) years, incorporating the parameters outlined in this section of this specification, and NACE SP0169, latest revision.
- (B) Most of the design parameters must be set by the CPS design engineers upon basis of experimental data and field conditions. However, DEP has set some common parameters which must be followed by CPS design engineers.
 - (1) The minimum current density to protect steel pipe must be considered as 1.00 mA/ft².
 - (2) An average of at least three (3) soil samples' resistivity at each sampling station taken at locations close to centerline of the pipe along the proposed water main route every 500 feet or less (depending upon the local soil conditions) must be used for calculating the number of anodes for each pipe segment. Soil resistivity must be measured by 4-Electrode Method in accordance with ASTM G57 and using ASTM G57 4-electrode soil boxes.
 - (3) If the water main area has stray current, proper methods to mitigate, constrain, and alleviate the stray current must be incorporated in the design.
 - (4) The Corrosion Specialist must use high potential magnesium anodes, installed along the water main as shown on the approved CPS design drawings. The system must include associated test stations, isolating joints, and all wiring and connections.
 - (5) The maximum number of magnesium anodes for any CP test station must be limited to no more than fifteen (15) only.

7.5. SUBMITTAL PROCEDURE

(A) CATHODIC PROTECTION DESIGN DRAWINGS

- (1) The Corrosion Specialist / Contractor must submit CPS drawings showing the anodes, CP test stations locations, street names, and other details on 24" X 36" or 22" X 34" drawings. These drawings must be submitted electronically to DEP-BWSO-ME&QA for review and approval.
- (2) The CPS drawings' title block must include the project name, contract number, and drawing sheet number for each drawing. The drawing number must incorporate a short form of the contract number.
- (3) All drawings must be in black ink and readable in minimum letter size 11 points. All dimensional lines must be black color.
- (4) All design drawings must be submitted as a single submittal. These drawings will include material requirements, GB layout, test station locations, test station details, and any other information necessary for the proper installation and operation of a CP corrosion control system.
- (5) The submittal must also include design calculations for anodes, different field data, and all assumptions made during the design phase.
- (6) The net weight of each anode determined by the Corrosion Specialist and as approved must be listed on CP design drawings.

(B) MATERIALS AND EQUIPMENT

- (1) The Contractor must submit a complete list of materials and equipment to be incorporated into the CP installation. This submittal will include descriptive data and catalog numbers allowing ready and complete item identification.
- (2) All materials are subject to approval of the DEP-BWSO-ME&QA. Additional information or samples of any material used, including anodes and mastic sealants, must be available for submittal upon request.

(C) FOR ALL SUBMITTALS

- (1) At the discretion of the Engineer, advance copies of all submittals may be sent directly to the DEP-BWSO-ME&QA, while formal submittals are processed through proper channels.
- (2) All material and design submittals must fully comply with **Sections 7.6 through 7.13** inclusive.

7.6. MATERIALS

- (A) The Contractor must furnish submittals for all other materials required for complete CPS under this contract. This includes permanent half-cells, steel rebars, wires, connectors, thermite welding materials, coating repair materials, PVC conduits, splicing materials, flange protectors, etc. that are required to complete the CPS to contract requirements.
- (B) The Contractor must furnish adequate storage facilities on the job site to protect the CP materials from environmental or other possible damage.
- (C) The Contractor must furnish hydrant valve boxes per **Standard Drawing No. WM0040** to be used as CP test stations. Only the top half of the valve box must be used for the test station assembly.
- (D) The materials furnished must be to industry standards. Proprietary items of any manufacturer must be avoided unless absolutely necessary and have been approved by the Engineer in consultation with DEP-BWSO-ME&QA.
- (E) The Contractor must furnish all other material as approved by the City and required for the corrosion control work under this contract. This includes, but is not limited to, anodes, wiring, connections, thermite welding materials, coating repair materials, PVC conduits, and splicing materials. The materials furnished must meet the requirements listed in this specification.

(F) ANODES

- (1) The net weight of each anode determined by the Corrosion Specialist must be listed on the CP design drawings.
- (2) Anodes must be high potential magnesium alloy meeting the requirements of ASTM B843 Grade M1C (UNS M15102), or DEP-BWSO-ME&QA approved equal.
- (3) Magnesium *ribbon anodes* must not be used unless the Corrosion Specialist sufficiently demonstrates the need for and the advantages of ribbon anodes for the project. The use of ribbon anodes must be approved by the Engineer in consultation with DEP-BWSO-ME&QA.
- (4) Anodes must be packaged in a permeable cloth bag or porous paper box with a backfill that consists of (by weight) 75% gypsum, 20% bentonite, and 5% anhydrous sodium sulfate. One hundred percent (100%) backfill must pass through a 20-mesh sieve and approximately fifty percent (50%) retained on a 100-mesh sieve.
- (5) Each anode must have a minimum 10-foot-long factory attached 12 AWG THWN (copper conductor with PVC insulation and nylon sheath) solid wire; anodes with 12 AWG TW (copper conductor with PVC insulation) solid wires are acceptable.
- (6) The Corrosion Specialist must provide Material Test Reports (MTR) and Certifications that the anodes meet the ASTM B843 Grade M1C chemical requirements for each heat of the anodes used.

(G) WIRE SPECIFICATIONS

- (1) Anode header wire must be black number 8 AWG seven stranded copper wire with high molecular weight polyethylene (HMWPE) insulated cable suitable for direct burial.
- (2) Water main leads (wires) for flange isolation testing and anode connections must be number 10 AWG stranded copper wire with THWN insulation to the colors specified in **Sections 7.9 and 7.10**.
- (3) Splices must be made with copper or copper alloy split bolts or with insulated Butt Splice Connectors manufactured by reputable manufacturers.
- (4) Splices must be insulated with two (2) layers of rubber splicing tape or of an approved equal; and must be coated with two (2) layers of vinyl tape.

(H) CONDUIT FOR ROADWAY CROSSING

- (1) Conduit for roadway crossings must be PVC conduit, Schedule 40 or higher. The conduit must have bushings at each end to prevent wire abrasion during pulling.

7.7. ELECTRICAL ISOLATION

(A) ISOLATED JOINTS FOR LINE VALVES AND CONTRACT LIMITS

- (1) All sections of the trunk main installed under this contract must be isolated from the remainder of the distribution system at the contract limits by isolating joints or couplings.
- (2) The water main being installed must be divided into isolated sections by installing isolating flanges at all line valve and auxiliary connection valve flanges.
- (3) Test stations to monitor the effectiveness of isolated joints and couplings must be installed for all isolating flange connections.

(B) ISOLATING JOINTS FOR BLOWOFFS AND AIR COCKS

- (1) Isolating flanges must be installed at blowoff and air cock valves. Test stations are not required for blowoff or air cock valves.

(C) FOREIGN STRUCTURES

- (1) The new water main must be isolated from sleeves, conduits, reinforcing rods, casings, and all other structures by physical means, or by the use of high strength dielectric materials.

- (2) Test stations must be placed at pipeline crossings as required or approved by the Engineer.
- (3) Under NO circumstances will the water main be shorted to a casing. At locations where casings are required, the pipeline will be isolated from the casing by installing approved insulating devices.

7.8. CATHODIC PROTECTION SYSTEM INSTALLATION

- (A) The Contractor and the Corrosion Specialist must install the CPS in tandem with the water main.
- (B) All CP material must be installed according to NACE SP0169 and NACE SP0286, manufacturer's recommendations, and the contract requirements.
- (C) The Corrosion Specialist or the Corrosion Specialist's AMPP certified Corrosion Technologist supervisors must supervise the CPS installation in tandem with the water main installation. Monitoring the installation is suggested to avoid any retrofitting and re-excavating for the CP components including anodes/half-cells.
- (D) All cuts and holidays in the water main's coating must be repaired and tested according to the coating manufacturer's recommendations, prior to backfilling. All repairs must be compatible with the shop-applied coating.

(E) ANODE INSTALLATION

- (1) Anodes must be placed as shown on the approved CP design drawings. Anodes must be placed approximately ten (10) feet apart in the bottom of the trench in native soil (not sand), one foot all around, and 3 to 5 feet offset of the pipe. Reasonable offset is allowable to clear rocky formations, concrete structures, or other immovable objects. All changes are subject to the approval of the Engineer in consultation with DEP-BWSO-ME&QA and must be noted on the as-built drawings.
- (2) Packaged anodes must be lowered into holes by rope sling or by grasping the cloth gather. Anodes will not be handled by the lead wire. Anodes with damaged lead wires will not be used.
- (3) Anode header cable must be spliced by stripping the casing off the anode header cable a maximum of two inches, without scoring the copper strands, and connecting the anode lead wire securely with a Burndy KS-17 connector or approved equal. The connection must be insulated with two (2) layers of rubber splicing tape or approved equal; and must be coated with two (2) layers of vinyl tape.
- (4) Where multiple anodes are to be installed on a header cable, the anode lead wires must be carefully spliced to the header cable as shown on the approved CP design drawing.
- (5) Anodes must be backfilled with approved soil on all sides. Under no circumstances must the anode be backfilled with sand. A minimum of five (5) gallons of water must be poured over the anode package immediately before backfilling.

(F) TEST LEAD CONNECTIONS

- (1) Test lead connections must be permanently made to the pipe at all test station locations. Test lead connection must conform to details shown on the approved CP design drawings.
- (2) To connect the lead wire to the pipe, a three-inch-by-three-inch window must be removed from the pipeline coating. The substrate metal must be cleaned to a bright finish with grinding and a wire brush / emery cloth.
- (3) Test leads must be wrapped around the pipe and tied on the top of the pipe & taped.
- (4) Test lead connections must be made using the exothermic welding (thermite welding) process, as approved by the Engineer. Each test lead wire must be connected to the pipe using the appropriate size charge and must remain mechanically secured and electrically conductive. Nominal distance between welds must be twelve (12) inches. Test lead connections must be covered with primer, tape, and/or coating, as directed on the approved CP design drawing.
- (5) All safety procedures recommended by the manufacturer must be observed. Only those workers familiar with the process and qualified should do the actual welding.

- (6) All welds must be tested by striking the molten weld deposit with a hammer or a file. If the weld becomes loose, a second weld must be performed not less than six (6) inches from the first. The second weld must be prepared and tested in the same manner as the first. A clean wire conductor must be used.

(G) TEST STATION INSTALLATION

- (1) Test station (TS) must be designed in such a way not to cause any damage to CP components during and after construction.
- (2) Wiring of test stations must be limited to maximum eight (8) wires and test stations must be identified with permanent tags to identify test station numbers.
- (3) Test station wiring must be placed in 3-inch nominal diameter PVC Schedule 40 conduit at all roadway crossings, and inside butterfly valve and IJ chambers right after the exothermic welding of the wires to the pipe and valve. Buried headers and/or conduit must be clearly marked with yellow warning tape buried one foot above the conduit. The 3-inch nominal diameter PVC conduit must stop at the bottom of the upper section of the hydrant valve box.
- (4) Each TS must have a unique number; this number must include a short form of the contract number.
- (5) Test stations must never be combined, except for the Isolating Joint / Groundbed (IJ/GB) test stations.
- (6) Assembled test stations must be filled with native soil as shown in the standard drawings, to provide contact for the copper-copper sulfate half-cell portable reference cell.
- (7) Eighteen (18) inches of slack must be left on each wire in each test station. In the event that a wire (including wire for a permanent reference cell) is too short to reach the test station, one splice per wire may be made to provide sufficient length. The additional wire must be the same size as the original wire; and must be the same color as the original wire.
- (8) All test stations must be located in the adjacent mall or sidewalk in heavy traffic areas. Reasonable offset is permitted to clear prevailing conditions. Location and traffic considerations will determine test station location on an individual contract basis. All changes are subject to the approval of the Engineer. All changes must be noted on the as-built drawings.

Those test stations located in grassy or undeveloped areas must be mounted in a 36" x 36" x 7" deep concrete slab. Locations of test stations must be shown on final as-built drawings.

(H) OTHER INSTALLATION

- (1) Permanent Reference Cell must be installed for all anode GB test stations, and could also be installed in IJ test stations, at the Corrosion Specialist's decision. Permanent Reference Cell must be backfilled with native soil one (1) foot around.
- (2) Steel Rebar Electrode must be installed in all anode GB test stations and IJ test stations, at the Corrosion Specialist's discretion.

7.9. WIRING FOR THE WATER MAIN

- (A) Number 10 White AWG stranded copper wire with THWN insulation for unprotected structure at an isolating joint.
- (B) Number 10 Red AWG stranded copper wire with THWN insulation for protected structure at a potential test station, anode test station, IJ test station, casings, or any other structure that is to be cathodically protected.
- (C) Number 10 Green AWG stranded copper wire with THWN insulation for casing.
- (D) Number 8 Black AWG seven stranded copper wire with high molecular weight polyethylene (HMWPE) insulated cable (suitable for direct burial) for an anode GB.
- (E) Number 12 Yellow AWG stranded copper wire with HMWPE insulation for a permanent reference cell.
- (F) Number 12 Purple AWG stranded copper wire with THWN insulation for a rebar test electrode.

7.10. WIRING FOR BUTTERFLY VALVE, VENTURI FLOWMETER, AND SHUT-OFF VALVES

- (A) Number 10 Red AWG stranded copper wire with THWN insulation for the North or West side of isolation flange.
- (B) Number 10 Blue AWG stranded copper wire with THWN insulation for the South or East side of isolation flange.
- (C) Number 10 Green AWG stranded copper wire with THWN insulation for the Valve Body.

7.11. CATHODIC PROTECTION SYSTEM TESTING

- (A) To ensure that the CPS is functioning properly, and that the criteria for protection as stated in NACE SP0169 and NACE SP0286 are met, field tests must be performed by AMPP Corrosion Specialist. The Engineer and DEP-BWSO-ME&QA must be informed of all testing dates and times at least three (3) working days before each testing. The Engineer must witness interim testing and final testing. DEP-BWSO-ME&QA must witness the interim testing and final testing.
- (B) After installation of each isolated section of pipe or group of isolated sections, interim / preliminary testing must be performed by the Corrosion Specialist in the presence of the Engineer and DEP-BWSO-ME&QA; satisfactory testing results should be achieved prior to the permanent restoration. All CP reports must be submitted through proper channels to DEP-BWSO-ME&QA for review and approval.
- (C) Field tests must be conducted using a copper-copper(II) sulfate electrode (CSE) reference cell and a high impedance voltmeter, having an internal resistance of at least 100,000 ohms per volt and a full-scale reading of two volts. Measurements and control of anode current at the anode test station must be measured using a low resistance milliammeter or another suitable test meter.
- (D) The completed CPS must be tested by Corrosion Specialist in the presence of the Engineer and DEP-BWSO-ME&QA personnel for acceptance and approval of the CPS.

7.12. CATHODIC PROTECTION SYSTEM ACCEPTANCE

- (A) The CPS must not be considered complete until a Final Report and As-built drawings have been submitted and accepted by DEP-BWSO-ME&QA. The report must be organized in an orderly chronological manner. The information included in the final report must contain, but not be limited to, the following:
 - (1) Cover page with current date.
 - (2) Statement of Limitation stamped and dated by AMPP Corrosion Specialist.
 - (3) Table of contents.
 - (4) Executive summary.
 - (5) System Description & Theory.

- (6) Test procedure.
- (7) Results & Discussion.
- (8) Conclusion & Recommendations.
- (9) Data Summary for all test results in tabulated form.
- (10) As-built Drawings showing all test station locations, number of anodes, wiring colors, nearby structures, distance from the street curb and street name, etc. A legend must be included on each sheet of the drawings. Drawings must be readable preferably on 8½" x 11" sheets with not more than three (3) test stations per sheet. All drawings must be signed off and sealed by the AMPP Corrosion Specialist with a current revision date and must be submitted through proper channels to DEP-BWSO-ME&QA for review and approval.
- (11) Two (2) sets of as-built drawings and final report as specified above duly signed and sealed by the AMPP Corrosion Specialist must be submitted to DEP-BWSO-ME&QA for review and acceptance.
- (12) The approved final report and as-built drawings must also be submitted electronically.

7.13. REFERENCE STANDARDS

All work performed under this specification must be done according to all applicable standards, codes, and regulations.

Unless otherwise specified, any reference made to a document will mean the latest published edition or revision of the referenced document in effect at the bid date of the project.

(A) PRIMARY REFERENCE STANDARD

- NACE SP0169 *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*

(B) SUPPLEMENTARY REFERENCE STANDARDS

- ASTM B843 *Standard Specification for Magnesium Alloy Anodes for Cathodic Protection*
- ASTM G57 *Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method*
- ASTM G193 (NACE/ASTM G193) *Standard Terminology and Acronyms Relating to Corrosion*
- AWWA C209 *Tape Coatings for Steel Water Pipe and Fittings*
- AWWA C210 *Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings*
- AWWA C214 *Machine-Applied Polyolefin Tape Coatings for Steel Water Pipe*
- AWWA C216 *Heat-Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings*
- AWWA C222 *Polyurethane Coatings and Linings for Steel Water Pipe and Fittings*
- NACE SP0286 *Electrical Isolation of Cathodically Protected Pipelines*
- SSPC-SP 2 *Hand Tool Cleaning*
- SSPC-SP 3 *Power Tool Cleaning*