

SECTION 026430
BAR WRAPPED CONCRETE STEEL CYLINDER PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installing new bar wrapped concrete steel cylinder pipe and fittings for buried water lines for sizes 20" to 60".

1.03 REFERENCES

- A. AASHTO .Standard Specifications for Highway Bridges.
- B. AREMA .Manual of Railway' Engineering, Volume II, Chapter 15.
- C. ASTM A 615- Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- D. ASTM C 33 .Standard Specification for Concrete Aggregates.
- E. ASTM C 35 .Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster
- F. ASTM C 150 .Standard Specification for Portland Cement.
- G. ASTM C 497 .Standard Test Method for Concrete Pipe, Manhole Sections, or Tile, Testing.
- H. ASTM D 512 .Standard Test Methods for Chloride Ion in Water.
- I. ASTM C 1107 (CRD C-621) .Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- J. ASTM D 1293 .Standard Test Methods for pH of Water.
- K. ASTM E 165 .Standard Test Methods for Dye Protection
- L. ASTM E 340 .Standard Test Method for Macroetching Metals and Alloys.
- M. ASTM E 709 .Standard Test methods for Magnetic Particle Testing.
- N. ASTM E 1032 .Standard Test Methods for Radiographic Examination of Weidments.
- O. ANSI/AWS A3.0 .Standard Welding Terms and Definitions.
- P. AWWA C 206 .Standard for Field Welding of Steel Water Pipe.

- Q. AWWA C 207 Standard for Steel Pipe Flanges for Waterworks Service Sizes 4 in. through 144 in.
- R. AWWA C 301 Standard for Pre-stressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids.
- S. AWWA C 303 Standard for Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.
- T. AWWA C 304 Standard for Design of Pre-stressed Concrete Cylinder Pipe.
- U. AWWA M 9- Concrete Pressure Pipe.
- V. NSF 61 Drinking Water System Components Health Effects.
- W. SSPC SP 7- Surface Preparation Specifications No.7 Brush Off Blast Cleaning.

1.04. SUBMITTALS

- A. Conform to requirements of 00 72 00 Article 25 Shop Drawings.
- B. Submit shop drawings and certification signed and sealed by Professional Engineer registered in State of Texas showing following:
 - 1. Manufacturer's pipe design calculations.
 - 2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by the Engineer. Provide final approved lay schedule on portable flash drive in Adobe portable document format (*PDF).
 - 3. Include hot tapping procedure.
 - 4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this section
- C. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed. Repair defects such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.
- D. Submit following within 45 days after manufacturing of pipe and fittings.
 - 1. Steel:
 - a. Steel reports as required in AWWA C 303, Section 5.2.5.

- b. Results of other tests of steel reinforcement required in AWWA C 303, Section 5.2.
- 2. Test Results.
 - a. Hydrostatic testing, acid etching, magnetic particle and x-ray weld test reports as required.
 - b. Compressive strength (7 and 28 day) test results for each type of coating and lining mix design.
- 3. Submit pipe manufacturer's certification that Bar Wrapped Steel Cylinder Pipe:
 - a. Cylinder assembly has been hydrostatically tested at factory.
 - b. Mortar coatings and linings were applied or allowed to cure at temperature above 32 degrees Fahrenheit.
- E. Submit following non-shrink grout for special applications:
 - 1. Manufacturer's technical literature including specifications for mixing, placing, and curing grout.
 - 2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C 1107, Non-shrink Grout and requirements of this specification.
 - 3. Certification product is suitable for use in contact with potable water.
- F. Submit certification for welder and welding operator demonstrating their certification within past 6 months in accordance with AWWA C 206. Indicate certified procedures and position each welder is qualified to perform.
- G. Calibrate within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is 11 required to have tag recording date of last calibration. Devices are subject to inspection by the Engineer.

1.05 QUALITY CONTROL

- A. Manufacturer to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by the Engineer and OAR. Perform manufacturer tests and inspections required by AWWA C 303 as modified by these Specifications. Correct nonconforming conditions.
 - 1. Cylinder and Joint Ring Assembly:

- a. Review mill certifications for conformance requirements of Specifications.
- b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.
- c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C 303. Maximum allowable thickness variation of cylinder shall not be less than determined thickness.
- d. Test cylinder/joint ring weld for tensile strength. Test one specimen for each 500 cylinder/joint ring assemblies in addition to those tests required by AWWA C30I.
- e. Reject pipe with dented steel cylinders.

2. Bar Rod

- a. Review mill certifications for conformance to requirements of Specifications.
- b. Inspect rod spacing during placement on cylinder.
- c. Test rod splices for each production run or minimum of once a week, whichever is less, for conformance with minimum strength criteria.

3. Pipe Lining Coating:

- a. Review mill certificates for each load of cement for conformance to ASTM C 150.
- b. Perform sieve analyses weekly for each source of coarse and fine aggregate for conformance to ASTM C 33.
- c. Inspect kiln recorder charts daily to confirm proper curing environment.
- d. Verify mortar thickness on each size of pipe to a tolerance of 1/16th of an inch of required thickness.
- e. Perform absorption tests in accordance with ASTM C 497, Method A, on cured mortar samples taken from pipes.
- f. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.
- g. Check physical integrity of cured mortar coating. Check cured mortar coating for soundness on every pipe in field in addition to manufacturing plant.
- h. Reject pipe with cracks in mortar coating exceeding 0.01" wide.

4. Protective Coatings: Check daily application rate and resulting dry film thickness.
- B. Gaskets.
1. Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness, and specific gravity after oven aging on one out of 100 gaskets.
 2. Stretch test each gasket splice to twice its unstretched length and inspect for defects.
- C. Weld Testing
1. Perform macro-etching tests for complete penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macro-etch of joint weld cross section, in accordance with ASTM E 340.
 2. Perform ultrasonic or x-ray testing of manual welds for fittings and special pipes. Perform dye penetration testing of manual lap welds for fittings and special pipes and for joint ring weld onto cylinder.
 3. Perform minimum of one set of weld test specimens in. accordance with ANSL'AWS A3.0 on each size, grade and wall thickness at minimum of every 3,000' of pipe manufactured; but perform no less than one test per project by each welding machine and each operator.
- D. Cast four standard test cylinders each day for each 50 cubic yards of concrete mortar coating or portion thereof for each coating and lining mix design placed in day. Perform compressive strength test at 28 days. No cylinder test result shall be less than 80 percent of specified strength. Reject pipe that does not meet minimum strength requirements.
- E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of the Engineer.
- F. Check physical dimensions of pipe and fittings: Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.

1.06 INSPECTION

- A. The Engineer and/or OAR may witness manufacture and fabrication of pipe and appurtenances. Independent testing laboratory under contract to the Engineer or Owner may perform tests at direction of the Engineer to verify compliance with these specifications. The Contractor shall arrange for Manufacturer to provide assistance to accomplish such testing, including equipment and personnel, at no additional cost to City.

PART 2 PRODUCTS

2.01 BAR WRAPPED STEEL CYLINDER PIPE

- A. Furnish pipe by same manufacturer.
- B. Provide bar wrapped steel cylinder pipe in conformance with AWWA C 303 and AWWA M 9, except as modified herein. Produce pipe cylinder to conform to AWWA C 303 except modify Section 4.5 to require that total cross-sectional area of bell ring plus cross-sectional area of bar reinforcement over bell ring exceed circumferential steel area in like length of barrel area by one-third.
- C. Use of pipe from inventory is permitted only if specifications and certifications are met. Provide testing records for such pipe.
- D. Do not use bar wrapped steel cylinder pipe in aerial crossings, exposed or other unburied areas.
- E. Pipe Manufacturer.
 - 1. Must have minimum of 5 years of manufacturer's pipe installations that have been in successful and continuous service.
 - 2. Must maintain on site or in plant minimum of four 22.5° bends per 10,000 linear feet of water line. Any combination of bends may be substituted at manufacturer's option (i.e. two 11.25° bends are equivalent to one 22.5° bend and will be counted as one fitting). Must be capable of delivering bends to job site within 12 hours of notification. These fittings are in addition to any fittings called out on Drawing and must be available at all times.
- F. Pipe Design Conditions:
 - 1. Working pressure: 90 psi.
 - 2. Hydrostatic field test pressure: 150 psi
 - 3. Maximum pressure due to surge: 150 psi.
 - 4. Minimum pressure due to surge: -10 psi.
 - 5. Unit weight of soil: 120 pcf minimum, unless otherwise specified.
 - 6. Minimum trench width: As shown on the drawings or indicated in Technical Specification 022020 "Excavation and Backfill for Utilities".
 - 7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

8. Design: Design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREA E-80 loads and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for transition width trench for all heights of cover.
 - a. Calculate moments and thrusts in wall based on earth load.
9. Increase longitudinal steel area (cylinder thickness) to prevent cylinder stress from exceeding 40% of minimum yield point at rated working pressure and 67% of minimum yield point at rated maximum surge pressure where pipe and fittings are subjected to longitudinal stresses induced by restrained joints or thrust blocks.
10. Groundwater Level: Design for most critical ground water level condition.
11. Modulus of elasticity (E) 30,000,000 psi.
12. Design stress due to working pressure to be no greater than 50% of minimum yield, and stress not to exceed 16,500 psi for mortar coated pipe.
13. Design stress due to maximum hydraulic surge pressure to be not greater than 75% of minimum yield, and stress not to exceed 24,750 psi for mortar coated pipe.
14. Modulus of soil reaction (E) < 1500 psi. If E > 1000 psi, do not use silty sand (SM) for embedment.
15. Deflection lag factor (DI) 1.2.
16. Bedding constant (K) 0.1.
17. Fully saturated soil conditions: $h_w = h$ = depth of cover above top of pipe.
18. Inside diameter of casing or tunnel liner must be minimum of 4" or greater than diameter of carrier pipe for small diameter water lines. Inside diameter of casing or tunnel liner *must* be minimum of 8" or greater than diameter of carrier pipe for large diameter water lines.
19. Exclude structural benefits associated with primary liner in design of pipe in tunnel installations.
 - a. Design pipe and joints to carry loads including overburden and lateral earth pressures, subsurface soil and water loads, grouting, other conditions of service, thrust of jacks, and stresses anticipated during handling and construction loads during installation or pipe.
 - b. Do not use internal removable stiffeners for pipe in tunnel, unless approved by the Engineer.
 - c. External welded stiffeners shall be permitted in design calculations for pipe, provided wall thickness is minimum of 1/2". Minimum clearances specified

between exterior pipe wall and tunnel liner applies to distance between outside diameter of external welded stiffener and tunnel liner.

20. Design pipe for transmitting potable water.
21. Tunnel and Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and any stress anticipated during handling and installation.

G. Coatings and Linings:

1. Material:
 - a. Lining: Provide Portland cement; ASTM C 150, Type I or II, as shown on the drawings or as required elsewhere in the Construction Documents.
 - b. Coating: Provide Portland Cement ASTM C 150, Type II with maximum of 5% tricalcium aluminate and pipe shall be placed with 6" cover of cement stabilized sand or use Type V.
2. Water Absorption Test: ASTM C 497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.
 - a. Test Value: Average minimum of 3 samples taken from same working shift, no greater than 9% for average value, and 11% for individual value.
 - b. Test Frequency: Perform tests each working shift until conformance to absorption requirements has been established by 10 consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift if absorption test results fail until conformance to absorption requirements is reestablished by 10 consecutive passing test results.
3. Apply one coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.
4. Coat and line access inlets, service outlets, test inlets and air release/vacuum relief riser pipe with same coating and lining of main pipe in accordance with AWWA C 303, Section 4, unless otherwise indicated on Drawings.
5. Do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.

6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than 100 square inches or 12 inches in greatest dimension. Allow no more than one patch on either lining or coating of pipe. Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod, or approved equal bonding agent for pipe patching.

H. Fittings and Specials:

1. Design fittings to same internal and external loads as straight pipe.
2. Manufacture in accordance with Technical Specification Section 02518 .Steel Pipe and Fittings for Large Diameter Water Lines.
3. Provide fabricated bends or fittings with minimum radius of 2-1/2 times pipe diameter.
4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed 50% of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug may not contain water.
5. Provide no specials less than 4' in length unless indicated on Drawings or approved by the OAR.
6. Butt Straps for Closure Piece: Provide at locations indicated on Drawings or authorized by the OAR. Minimum 12" wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection at butt-strap joints.
7. Provide minimum 6" welded outlet for inspecting each closure section, unless access manway is within 40' of closure section.
8. Provide Densco petroleum based tape or approved equal for exposed portions of nuts and bolts.

I. Joints:

1. AWWA C 303 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on Drawings. Refer to Technical Specification Section 02511 .Water Lines for details on joints and jointing.
2. Rubber-Gasketed Joints: Double weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell and spigot onto steel cylinder.
3. Restrained Joints: Restrain joints by welding or harnessing joints.
 - a. Design Pressure: 1.5 times working pressure.
 - b. Harnesses Joints: AWWA M 9, clamp or snap ring type, except where prohibited.
 - c. Groundwater Level: Assumed to be .equal to natural ground surface.

- d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.
- 1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle. Provide restrained joints between stations identified in Article 3.06 RESTRAINED PIPE REQUIREMENTS.
 - 2) Cylinder thickness not to be less than that defined in AWWA C 303, Table 2, and minimum nominal cylinder thickness.
 - 3) Allow cylinder thickness to reduce linearly from maximum calculated thickness to minimum thickness required by design over required length (as determined in Paragraph 2.01 J.3.d.1) of restrained joints.
 - 4) Provide full circumferential welds at joints required to be welded.
- J. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Technical Specification Section 02518 Steel Pipe and Fittings for Large Diameter Water Lines.
- K. Pipe Flanges: AWWA C 207 for standard steel flanges of pressure class corresponding to pipe class.
- L. Pipe Lengths: Provide pipe sections in standard lengths with minimum length of 16' and maximum length as indicated on shop Drawings and approved by the OAR. Gasketed joints are allowed on standard lengths of pipe. Non-standard pipe lengths must be approved by the OAR and joints must be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark each pipe section with durable marking to show location and pipe pressure.
- M. Hydrostatic Test of Cylinder: In accordance with AWWA C 303, at point of manufacture. Hold test for minimum 2 minutes for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.
- N. Transport fittings with end caps. Remove end caps just prior to installation.
- O. Transport fittings 36" in diameter and larger with stulls. Remove stulls after completion of backfill.
- P. Provide radius of curve as indicated on Drawings unless approved by the OAR. Make curves and bends by deflecting joints, by use of beveled joints, or by combination of two methods, unless otherwise indicated on Drawings. Do not exceed deflection angle recommended by pipe manufacturer. Provide beveled pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case, provide sections throughout curve of substantially equal length.

Q. When manufacturing straight pipe sections, manual welding is allowed for following:

1. Tack welding of coils and plates during continuous pipe making process.
2. Rewelding and repairing structural defects in plate and automatic machine welds.
3. Attaching new coil of steel to previous coil.

2.02 BAR ROD

- A. Conform to requirements of ASTM A 615, AWWA C 303 and this specification.
- B. Test foreign manufactured rod by local independent laboratory.
- C. Rod manufacturer is responsible for performing mechanical tests required in ASTM A 615.
- D. Pipe manufacturer is responsible for requiring rod manufacturer to submit certified results of chemical and mechanical tests, performed by rod manufacturer. Pipe manufacturer is responsible for performing mechanical tests, and is required to attest to such in affidavit of compliance.
- E. Do not use rod with visible pitting.

2.03 GROUT FOR JOINTS AND SPECIAL APPLICATION

- A. Joint Grout:
 1. Cement Grout Mixture: One part cement to two parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.
 2. Water: Potable water with total dissolved solids less than 1000 mg/l; ASTM D 512 chloride ions less than 100 mg/l for slurry and mortar cure; ASTM D 1293 pH greater than 6.5. Use potable water with 2SGppm limit on chlorides and sulfates.
 3. Portland Cement: ASTM C 150, Type II with a maximum of 5% tricalcium aluminate. and pipe shall be placed with 6" cover of cement stabilized sand or use Type V as shown on the drawings or as required elsewhere in the Construction Documents. Provide one type of cement for entire project.
 4. Sand:
 - a. Interior joints: ASTM C 35 fine graded plaster sand.
 - b. Exterior joints: ASTM C 33 natural sand with 100 percent passing No. 16 sieve.

5. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and as requested by the OAR. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout mixed more than 20 minutes that is not at proper moisture content or specific gravity.
- B. Nonshrink Grout for Special Applications, Patches and Repairs.
1. Conform to requirements of ASTM C 1107, Non-Shrink Grout.
 2. Pre-blended factory-packaged material manufactured under rigid quality control.
 3. Contain non-metallic natural aggregate, be non-staining and non-corrosive.
 4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.
 5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.
 6. Non-bleeding and non-segregating at fluid consistency.
 7. Contain no chlorides or additives which may contribute to corrosion of bar *wrapped* steel cylinder pipe.
 8. Free of gas-producing, gas-releasing agents.
 9. Resist attack by oil or water.
 10. Mix, place, and cure in accordance with manufacturer's recommendations. Upon 72 hours' notice, provide services of qualified representative of nonshrink grout manufacturer to aid in use of product under job conditions.
 11. Mix nonshrink grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and as requested by the OAR. Add additional non-shrink grout to mixed non-shrink grout to bring to proper moisture content or specific gravity. Discard grout mixed more than 20 minutes that is not at proper moisture content or specific gravity.
 12. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.
- C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

- D. Joint Wrapper: Minimum width of 9" for 33" diameter and smaller; minimum width of 12" for diameters greater than 33" hemmed at edge to allow threading with minimum 5/8" wide steel strap. Provide minimum 6" wide Ethafoam strip sized, positioned, and sewn such that two circumferential edges of Ethafoam are 12" from outer edge of wrapper.

2.04 CATHODIC PROTECTION

- A. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.
- B. Electrically isolate main line from other connections. Use insulating type joints or non-metallic pipe unless otherwise indicated on Drawings.
- C. Provide flange adapter with insulating kit as required when connecting new piping to existing piping.

2.05 INSPECTION AND SHIPPING

- A. Permit the OAR to inspect pipes or witness pipe manufacturing. Inspection shall, not relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications. Should the OAR elect not to inspect manufacturing, testing, or finished pipes, it in no way implies approval of products or tests.
- B. Manufacturer's Notifications to Customer: Should the OAR wish to see specific pipes during manufacturing process, manufacturer shall provide the OAR with minimum of 3 weeks advance notice of when and where production of those pipes will take place.
- C. Repair damage to pipe or protective lining per manufacture specifications before final acceptance.
- D. Shipping: Where required, provide pipe and fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

PART 3 EXECUTION.

3.01 INSTALLATION

- A. In the event of conflict between City Standard Specification Section 050200 "Welding", and the requirements of this specification, Specification Section 050200 will govern.
- B. Conform to requirements of City Standard Specification Section 026402 "Waterlines". Do not install pipe without approved lay schedule.
- C. Install stulls prior to placement of pipe, bends, and fittings to prevent deflection during installation. Provide stulls consisting of timber struts with end blocks shaped to fit curvature of interior surface of pipe or other appropriate configuration and material. Firmly edge and secure stulls to blocks so that they will remain intact position during handling and

installation. Provide stulls adequate to resist loads encountered without structural failure to stull members or damage to pipe. Where applicable, place stalls at such lengths so as to elongate vertical diameter of pipe as required to suit trench conditions encountered.

- D. Install pipe within six months of pipe being manufactured.
- E. Manufacturer shall make available services of representative, throughout project duration when deemed necessary by the Engineer, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs, and general construction methods affecting pipe.
- F. Bedding and Backfilling
 - 1. Conform to requirements of City Standard Specification Section 022020 "Excavation and Backfill for Utilities".
 - 2. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection.
 - 3. Do not move trench support system (trench safety system) once bedding material is compacted.
 - 4. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.
 - 5. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by the Engineer or OAR. Subsequent backfilling thereof shall not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of the OAR.
 - 6. Remove blocking after placing sufficient backfill to hold pipe in position.
- G. Follow non-shrink grout manufacturer's specifications for non-shrink grouting.
- H. Store pipe at job-site with securely-fastened plastic end caps to maintain moist pipe interior. Promptly replace damaged end caps to avoid shrinkage or cracking of cement-mortar lining. Immediately replace damaged plastic end caps. Do not leave uncapped for more than 4 hours.
- I. Deviation of installed pipe in any one pipe section from line and grade shown on approved shop drawing layout shall not exceed 2" from grade and 3" from line. No deviation from line and grade at contact interfaces are allowed.

J. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by the OAR, in-place survey data for pipe laid each day and submit copy of data to the OAR at end of that day. Survey data to include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).

K. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.
2. Electrically test where required after installation of pipeline is complete.

3.02 DEFLECTION

- A. Allowable deflection from specified diameter determined as follows:
Allowable Deflection $(D)^2/4000$, (D= Nominal inside pipe diameter in inches.)
- B. Deflection may be measured by the OAR at any location along pipe. Arithmetical averages of deflection are not acceptable.
- C. If deflection exceeds that specified, remove entire portion of deflected pipe section and install new pipe as directed by the OAR at no cost to City.

3.03 CLOSURES AND APPROVED PIPE MODIFICATIONS.

- A. No modifications of standard pipe for closures shall be permitted in the field. No field cutting of pipe or exposure of bar wire is permitted without written approval from the OAR.
- B. Pipe manufacturer's representative and the OAR to entirely witness closures and approved pipe modification efforts.
- C. Provide minimum lap of 4" between member being joined and edge of butt strap. Weld on both interior and exterior, unless otherwise approved by the OAR.
- D. Provide full circumferential welds on joints required to be welded. Employ independent, certified testing laboratory, approved by the OAR, to perform weld tests on field welds. Include cost of such testing in contract unit price for water lien. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for 100 percent of joint welds. Maintain records of tests. If defective weld is revealed, repair defective weld, and retest. Use wire and flux from same manufacturer throughout an entire project.
- E. Fill wrapper in field and allowing excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint, and secure in place.

- F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.04 VISIBLE CRACKS

- A. No visible cracks longer than 6 inches, measured to be within 15 degrees of line parallel to pipe longitudinal axis, are permitted except:
 - 1. In surface laitance of centrifugally cast concrete,
 - 2. In sections of pipe with steel reinforcing collars or wrappers, or
 - 3. Within 12" of pipe ends.
- B. Repair interior lining cracks that exceed 1/16" (0.0625 inches) wide.
- C. Reject pipe with exterior coating cracks that exceed 0.01" wide.
- D. Immediately remove pipe from site if pipe has cracks exceeding limitations and cracks are not repairable.

3.05 FIELD REPAIR PROCEDURES FOR COATING/LINING

- A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with non-shrink grout conforming to section 2.03 B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with non-shrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off non-shrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.
- B. Pipe with defective coating areas greater than 6" in diameter cannot be used. Immediately remove pipe from project.
- C. Reject pipe if steel cylinder is dented while making field repair. Immediately remove pipe from project.

3.06 RESTRAINED PIPE REQUIREMENTS

- A. As indicated on the plans

PART 4 MEASUREMENT AND PAYMENT.

4.01 Measurement

Unless otherwise specified on the Bid Form, pipe will be measured by the linear foot along the centerline of installed, in place, bedded, restrained, and accepted pipe.

4.02 Payment

Payment will be made per linear foot installed pipe, to include handling, bedding, restraining, connecting, and testing pipe for proper installation acceptance.

THIS PAGE INTENTIONALLY BLANK