

SECTION 331020

FORCE MAINS

PART 1 - GENERAL

1.1 SCOPE

- A. This specification provides the requirements for design and installation of force main systems servicing wastewater pumping stations.

1.2 GENERAL

- A. The following specification is intended for use for the design, selection of materials and construction of force main projects. Design and construction shall comply with the applicable design and installation requirements as established by the Florida Department of Environmental Protection (FDEP) and the most recent edition of "Recommended Standards for Wastewater Facilities (Ten States Standards)". The force mains shall meet the requirements of the FDEP Permit if applicable. The specifications herein state the minimum requirements of City of North Port Utilities (NPU or City).
- B. GENERAL SPECIFICATIONS: Units described shall be new, unused, and of the current year's production.
- C. WORK INCLUDED: The Contractor shall, unless specified otherwise, furnish all labor, materials, equipment, tools and all other associated appurtenances, necessary to do the work required under the contract to include but not limited to unloading, hauling, and distributing all pipe, fittings, valves and appurtenances. The Contractor shall also remove any surfacing as required; excavate the trenches and pits to the required dimensions; construct and maintain all required traffic control measures; sheet, brace, and support the adjoining ground or structures where necessary; handle all drainage or ground water; provide barricades, guards, and warning lights; lay and test the pipe, valves, fittings and appurtenances; backfill and consolidate the trenches and pits; maintain all surfaces over the trench until surface restoration is completed; restore the surfaces unless otherwise stipulated; remove surplus excavated material; and clean the site of the work. The Contractor shall also furnish all labor, materials, equipment, tools and all other associated appurtenances required to rearrange sewers, conduits, ducts, pipes, or other structures encountered in the installation of the work.

- D. LOCATION OF THE WORK: The location of the work is as shown in the Contract Documents.
- E. COORDINATION OF THE WORK: The Contractor shall be responsible for the satisfactory coordination of the construction of the force mains with other construction and activities in the area. Delays in work resulting from lack of such harmony shall not in any way be a cause for extra compensation by any of the parties.
- F. WORKING HOURS: The work shall be carried out in accordance with the contract documents and not to cause any unreasonable nuisance to affected residents. Under emergency conditions, this limitation may be waived by the written consent of the City.

1.3 METHOD OF MEASUREMENT AND PAYMENT

The work shall be measured, and the compensation determined in the following manner.

- A. FORCE MAINS: Direct bury and directional bore force main pipe shall be paid for at the contract bid price per lineal foot for each size and type of material specified, which shall include the cost of furnishing all pipe, pipe bend sections, jointing material, restraints, stainless steel stiffeners, bedding material and all other appurtenances and of delivering, handling, laying, dewatering, trenching, sheeting and backfilling, pigging, furnishing and installing flowable fill used for tunneling/deflecting pipe under and adjacent to existing storm piping/structures (unless separate bid item is provided). Bid price shall also include testing, restoring the surface (unless separate bid item is provided), necessary permits, and all material or work necessary to install the pipe complete in place at the depth specified on the plans and/or as directed by the City and Engineer.

The length of pipe for direct bury installation for which payment is made shall be the actual overall length measured along the axis of the pipe without regard to tee sections or bend sections. All lengths shall be measured in a horizontal plane unless the grade of the pipe is more than fifteen percent (15%). No payment consideration will be given to depth zones for the installation of the force mains.

The length of pipe for directional bore force mains pipe shall be measured by measuring the length pipe before installation and subtracting the lengths of the pipe cut from the ends of pipe when the bore pipe is connected to the pipe on either end. The difference is the length of the pipe in the ground.

- B. DUCTILE IRON FITTINGS: Ductile iron fittings are incidental to pipe

installation and there shall be no separate pay item. All other items including and not limited to bolts, gaskets, jointing materials, labor, and testing shall also be considered incidental to the project, with no separate pay item.

- C. TIE BACK ASSEMBLY: The tie back assembly, if required, for connection to existing facilities which are not properly restrained, shall be incidental to the pipe installation and there shall be no separate pay item. All ancillary work and materials are incidental to the pipe installation and there is no separate pay item, which includes furnishing tie back assembly device, stainless steel threaded rods, fittings, concrete blocking, restraints and any other appurtenances and of delivering, handling, excavation, sheeting, backfilling, dewatering, restoring of the surface and all material or work necessary to install the unit complete in place at the depth specified on the plans.
- D. IDENTIFICATION/MARKER TAPE: Marker tape and associated appurtenances to install shall be incidental to the force main construction.
- E. TESTING: All required testing shall be considered incidental to the project and therefore no direct compensation will be made.
- F. MISCELLANEOUS: All other items required for the completion of the project and not included as a specific bid item shall be considered incidental to the project and no additional compensation will be made.

1.4 REFERENCED STANDARDS (LATEST REVISION)

AWWA: C-153, C-900, C-905, C-909, C-906-90, C-151, C-153, C-111, C-600, C-651, and C-652

ASTM: A-139, D-1785, D-1869, D-1120, D-2241, D-3350, D-1248-68, D-1598, D-1599

FDEP: Wastewater Collection/Transmission System Requirements

AASHTO Code

Florida Administrative Code (FAC)

Ten States Recommended Standards for Wastewater

1.5 SUBMITTALS

The Contractor shall submit in writing documentation to justify approval

of these materials by the City prior to the start of the project.

The Contractor's submittals shall include the statement that the submittals have been reviewed and the materials meet the contract specifications and/or standard details.

The Contractor shall provide proof of supplier certification/training for butt-fusing pipe for any employee fusing pipe.

Final approval is at the discretion of the City and Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

Pipe used for force main systems shall be either PVC, HDPE or DI pipe. Pre-stressed concrete cylinder pipe is not allowed. The materials used in this work shall be all new and conform to the requirements for class, kind, size and material as specified below.

All pipe furnished for force main installations shall be of the type, kind, size, and class indicated for each particular line segment as shown on the engineering drawings and/or designated in the Contract Items.

A. POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTING:

1. PVC Pipe: PVC pipe for force mains shall conform to the requirements of AWWA C-900 four inch (4") through eighteen inch (18"), shall have a minimum working pressure of 100 psi and a dimension ratio (DR) of 25 for all open cut and direct bury installations with a minimum of thirty-six inches (36") of cover. For shallower depth, the type of pipe and installation shall require prior City approval. The manufacturer shall insure all quality control test and AWWA requirements are complied with during the production of PVC pipe. Approved PVC Pipe (FM):
 - a. Certainteed/North American Pipe Company
 - b. J-M Manufacturing
 - c. Diamond
 - d. National Pipe & Plastics
2. C-900 pipes shall have an integral bell formed with a race designed to accept the gasket in accordance with their respective AWWA requirements. The spigot end shall have a bevel and a stop mark on the outside diameter to indicate proper insertion depth. Provisions shall be made for expansion and contraction at each joint. All surfaces of the

joint where the gasket may bear shall be smooth, free of cracks, fractures, or imperfections that could adversely affect the performance of the joint.

3. Pipe Color: All C-900 force main pipes shall be green in color with a PVC ASTM D-1120 and ASTM D-2241 reference, the class pressure rating, and the DR number permanently and plainly marked on the pipe.
4. Joints: All PVC pipe shall have integral bell push on type joints conforming to ASTM D3139.
5. Fittings: All ductile iron fittings shall be in accordance with AWWA Specification C-153 and as a minimum have the same pressure rating of the connecting pipe. All ductile iron fittings shall be either:
 - a. Fusion bonded epoxy coated as per AWWA Specification C-116 or
 - b. Ceramic epoxy coated as per ASTM Specifications F-4176-95A, G-95, B-117, D-1308 and E-96

All exposed fasteners such as bolts, nuts, washers, and threaded rod shall be Type 316 stainless steel and all buried fasteners such as bolts, nuts, fasteners, washers, and threaded rod shall be “Cor-Ten” steel or Cor-blue coated. Mechanical joint bolts shall not protrude more than one-half inch ($\frac{1}{2}$ ”) through the nut after joints are assembled.

6. Fastener Threads: All stainless-steel fastener threads shall be coated with an anti-seize compound as approved by the City.

B. HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

1. HDPE pipe and fittings shall be a PE3408 high density, extra-high molecular weight polyethylene manufactured from first-quality high density polyethylene resin containing no additives, fillers, or extenders. The HDPE pipe shall have an ASTM D3350 cell classification of PE 345434C, and shall meet or exceed the properties listed in Table 02618-1 of this specification. The HDPE pipe shall meet the requirements of AWWA C906 and shall match ductile iron OD pipe sizing. The HDPE pipe and fittings shall be SDR-11 Phillips Driscopipe Series 1000, Chevron Plexco, or approved equal, or unless the Engineer or City indicate otherwise on the plans. The HDPE pipe shall bear the approval seal of the National Sanitation Foundation (NSF). All polyethylene piping shall have ductile iron pipe nominal outside diameters.

Individual sections of HDPE piping shall be joined together by thermal butt-fusion to make a continuous section of pipe as recommended by the pipe manufacturer. Bends in HDPE pipe shall not be within ten (10) pipe

diameters from any fitting or valve. The minimum radius of curvature shall be thirty (30) pipe diameters and bending shall not cause kinking. HDPE piping shall not be joined by solvent cements, adhesive or threaded type connections. The fused joints shall have equal or greater tensile and hydrostatic strength than the pipe.

The color marking stripes shall be aligned during the fusing process and the pipe shall be pulled through the bore to allow identification of the type of system utilizing the HDPE pipe.

The pipe shall include the following characteristics:

| Property | Specification | Unit | Nominal Value |
|--|---------------------|----------------------|----------------------|
| Material Designation | PPI/ASTM | | PE3408 |
| Material Classification | ASTM D-1248 | | III C 5 P34 |
| Cell Classification | ASTM D-3350 | | 345434C |
| Density | ASTM D-1505 | gm/cm ³ | 0.955 |
| Melt Index | ASTM D-1238 | gm/10 min. | 0.11 |
| Flex Modulus | ASTM D-790 | psi | 135,000 |
| Tensile Strength | ASTM D-638 | psi | 3,200 |
| HDB @73NF | ASTM D-2837 | psi | 1,600 |
| U-V Stabilizer | ASTM D-1603 | %C (Carbon Black) | 2.5 |
| Hardness | ASTM D-2240 | Shore "D" | 65 |
| Compressive Strength (yield) | ASTM D-695 | psi | 1,600 |
| Tensile Strength @ Yield (Type VI Spec.) | ASTM D-638 (2"/min) | psi | 3,200 |
| Elongation @ Yield | ASTM D-638 | %, minimum, | 8 |
| Tensile Strength @ Break (Type VI Spec.) | ASTM D-638 | psi | 5,000 |
| Elongation @ Break | ASTM D-638 | %, minimum | 750 |
| Modulus of Elasticity | ASTM D-638 | psi | 130,000 |
| Linear Thermal Expansion Coefficient | ASTM D-696 | in/in/NF | 1.2X10 ⁻⁴ |
| Brittleness Temperature | ASTM D-746 | NF | <-180 |
| Vicat Softening Temperature | ASTM | NF | 257 |

2. All fittings and sleeves used with high density polyethylene (HDPE) pipe shall be fusion bonded epoxy coated ductile iron with mechanical joints rated to 350 psi and conforming to AWWA C-153 and C-111. All MJ

fitting connections to polyethylene pipe shall be restrained with Mega-Lug restrainers. The HDPE pipe shall be reinforced on the ends using stainless steel wedge internal stiffeners.

The mechanical connection to MJ fittings and sleeves shall use mechanical restraints that meet specification requirements. Size-on-size mechanical connection to PVC or DI pipe shall be by compact ductile iron solid sleeves with Mega-Lug restrainers. No electro fusion fittings shall be used with HDPE unless specific written approval is provided by the City and Engineer.

HDPE molded butt fittings and couplings for non-standard fittings and couplings shall require special approval from the City for installation.

C. DUCTILE IRON PIPE AND FITTINGS

1. The ductile iron pipe covered by this specification shall be the push-on joint type or mechanical joint type, centrifugally cast to conform to all requirements of AWWA Specifications C-151 and C-153, latest revisions for pipe diameters four inch (4") and larger.

The maximum allowable deflection of the pipe shall not exceed two percent (2%) of the pipe diameter. Extra protection shall be provided for underground DI pipe and fittings within areas of severe corrosive conditions. The soil-test evaluation to determine the necessity for extra protection in suspect areas shall be as set forth in ANSI Standard A21.5. Additionally, where other existing utilities are for a distance of 20 feet to each side; and, when the installed parallel to and within 10 feet (10') of same, protection shall also be provided. Ductile iron pipe will be fully encased in an eight (8) mil polyethylene sleeve, in accordance with AWWA C-105, Method A. The pipe and the polyethylene sleeve shall be color coded green by a means acceptable to the City. Approved Ductile Iron Pipe:

- a. American
 - b. McWane
 - c. U.S. Pipe and Foundry
 - d. Griffin
2. All piping and fittings shall be either:
 - a. Fusion bonded epoxy coated as per AWWA Specification latest revision or
 - b. Ceramic epoxy coated as per ASTM Specifications F-4176-95A, G-95, B-117, D-1308 and E-96.
 3. Polyethylene material shall conform to ASTM Standard Specification

D1248-68, latest revision. All ductile iron piping shall be marked "DUCTILE IRON" in large letters. The nominal wall thickness shall be plainly marked on each piece of pipe and the pipe installed so that the markings can be read from the top of the trench.

Minimum thickness of ductile iron pipe shall be as follows:

| | | |
|-----------------------|-------|----------|
| 3" Ductile Iron Pipe | 0.25" | Class 51 |
| 4" Ductile Iron Pipe | 0.26" | Class 51 |
| 6" Ductile Iron Pipe | 0.25" | Class 50 |
| 8" Ductile Iron Pipe | 0.27" | Class 50 |
| 10" Ductile Iron Pipe | 0.29" | Class 50 |
| 12" Ductile Iron Pipe | 0.31" | Class 50 |
| 14" Ductile Iron Pipe | 0.33" | Class 50 |
| 16" Ductile Iron Pipe | 0.34" | Class 50 |
| 18" Ductile Iron Pipe | 0.35" | Class 50 |
| 20" Ductile Iron Pipe | 0.36" | Class 50 |
| 24" Ductile Iron Pipe | 0.38" | Class 50 |
| 30" Ductile Iron Pipe | 0.39" | Class 50 |
| 36" Ductile Iron Pipe | 0.43" | Class 50 |
| 42" Ductile Iron Pipe | 0.47" | Class 50 |
| 48" Ductile Iron Pipe | 0.51" | Class 50 |
| 54" Ductile Iron Pipe | 0.57" | Class 50 |

4. Rubber gasket joints shall be in accordance with AWWA Specification C-111 latest revision.
5. All fittings shall be in accordance with AWWA Specification C-153 latest revision and have the same pressure rating of the connecting pipe. All exposed fasteners such as bolts, nuts, washers, and threaded rod shall be Type 316 stainless steel. All buried fasteners such as bolts, nuts, washers, and threaded rod shall be "Cor-Ten" steel or Cor-blue coated steel. Mechanical joint bolts shall not protrude more than one-half inch (1/2") through the nut after joints are assembled.
6. All stainless-steel fasteners threads shall be coated with an anti-seize compound as approved by the City.

D. PIPE AND FITTINGS UNLOADING AT SITE

The Contractor shall inspect each shipment of pipe and fittings and make provisions for a timely replacement of any damaged material. The Contractor shall unload by hand or use canvas slings to avoid scratching the pipe. The Contractor shall not sling or drag pipe over an abrasive surface. Pipe or fittings damaged during handling shall be removed from

the site and replaced with new pipe and/or fittings. The Contractor shall follow the manufacturer's storage specification and store pipe and fittings in such a manner that prevents damage due to crushing, piercing, excessive heat, harmful chemicals, and exposure to sunlight.

E. IDENTIFICATION TAPE AND ELECTRONIC MARKER BALLS

1. Force main identification tape shall be installed one foot (1') below final grade over the centerline of the pipe. The tape one foot (1') below final grade shall be the detectable type and shall be laid continuously without gaps between ends over all installed pipe. The tape shall have the words "Caution: Buried Sewer Line Below" printed continuously along its length. The tape shall be the detectable type.
2. 3M electronic marker balls shall be installed twenty-four (24) inches below final grade, above pipe, at all bends or changes in alignment and every two hundred and fifty feet (250') along the pipe between bends.

PART 3 – EXECUTION

3.1 CONSTRUCTION REQUIREMENTS/INSTALLATION

Direct Bury, Directional Bore, and Jack and Bore: All direct bury, directional bore, and jack and bore force main pipe shall be installed at a minimum depth of thirty-six inches (36") or as approved by the City. If additional fittings are required where not shown on the engineering drawings to maintain alignment around curves, the Contractor shall provide the required number fittings. These fittings are incidental to construction and there is no separate pay item.

Piping, fittings, valves and appurtenances shall be installed in accordance with these Standards, including the NPU Standard Details, plans, all applicable AWWA standards, and with the manufacturer's recommendations for the applicable service.

All types of pipe shall be handled in such a manner as will prevent damage to the pipe or coating. Accidental damage to the pipe or coating shall be removed from the job site and replaced at no additional cost to the City. When not being handled, the pipe shall be supported on timber cradles or on properly prepared ground, graded to eliminate all rock points and to provide uniform support along the full length. When being transported, the pipe shall be supported at all times in a manner which will not permit distortion or damage to the lining or coating. Any unit of pipe that, in the opinion of the City, is damaged by the Contractor shall be removed from the site of the work and replaced with another unit. Joint gaskets shall be stored in a clean, dark, dry location until immediately before use.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned and re-laid. At all times when the pipe laying is in progress, the open ends of the pipe shall be closed by a water-tight plug or by other means approved by the City to ensure absolute cleanliness inside the pipe. The Contractor shall pig the force main prior to final acceptance by the City and the cost is incidental to the force main installation/construction cost. There will be no separate pay item for pigging unless otherwise approved by the City.

NOTE: If the new construction is tying into existing utilities, the Contractor shall verify the existing utilities, such as fittings and valves, are restrained prior to the start of installation of the valve or piping. If not properly restrained, the Contractor shall notify the City in writing and shall restrain the existing utility as approved by the City.

A. DIRECT BURY OF MATERIAL

1. Open cut PVC force main piping shall be installed with a minimum of thirty-six inches (36") of cover. For shallower depth, the type of pipe and installation shall require prior City approval.
2. Proper implements, tools, and facilities satisfactory to the City shall be provided and used by the Contractor for the safe and convenient execution of the work and the testing. All pipe, fittings, and valves shall be carefully lowered into the trench in such a manner as to prevent damage to force main materials and protective coatings and linings. The force main materials shall not be dropped or dumped into the trench. The pipe shall be laid with the manufacturers lettering designating the type and size of pipe visible from the top of the open trench. Wherever it is necessary to deflect pipe from a straight line in either the vertical or horizontal plane to avoid obstructions or where long-radius curves are permitted, the amount of pipe or joint deflection shall not exceed fifty percent (50%) of the manufacturer's recommended limit. Pipelines intended to be straight shall not deviate from the straight line at any point in excess of one inch (1").
3. Open cuts of roads for trenching and direct bury of force mains shall not exceed eight feet (8') in width. All effort shall be made to minimize the width of the trench and the amount of restoration.
4. All existing materials removed to facilitate the tunneling or deflecting of direct bury piping under or adjacent to existing storm piping and/or structures shall be replaced by flowable fill. Prior to placing flowable fill, the area between the direct bury piping and existing piping or structure

shall be hollowed out to a defined cavity along the length of the direct bury piping. The Contractor is responsible for filling the entire cavity with flowable fill and replacing the flowable fill as necessary throughout the contract and warranty period should erosion occur.

5. PVC pipe may be laid in the trench in single sections or preassembled multiple sections including no more than one full stick of pipe, one partial stick of pipe, and intervening required fittings and/or valves. Preassembled sections of pipe shall be carefully fed by hand or with the use of approved equipment on the pipe bed. The Contractor shall provide pockets in the pipe bed material to eliminate any concentration of loads on the bell ends or joints. The ends of mechanical joint pipe and fittings and rubber gasket joint pipe and fittings shall be clean of all dirt, grease, and foreign matter prior to installing fittings or joining of pipe sections. A joint lubricant shall be applied to all gaskets prior to joining two pipe sections together. No lubricant shall be used that harbor bacteria or damage the gaskets.
6. Cutting pipe for inserting valves, fittings, or closure pieces shall be in a neat and skilled manner without damaging the pipe or lining and to leave a smooth end at right angles to the axes of the cut pipe. The cut end of mechanical joint pipe shall be dressed to remove sharp edges or projections which may damage the rubber gasket. For push-on joints, the Contractor shall dress the pipe cut ends by beveling as recommended by the manufacturer.

B. DIRECTIONAL BORE OF MATERIAL

1. Proper implements, tools, and facilities shall be provided and used by the Contractor for the safe and convenient execution of the work. The Contractor shall meet the jointing and cutting pipe direct bury force main piping requirements as they apply to the directional bore. A log of the bore depths shall be based on one-foot intervals staking from the entry and exit locations and intermediate centerline. The vertical and horizontal location readings shall be plotted on a one inch (1") equals twenty feet (20') natural scale drawing which shall be provided to the City within 48 hours of completion of the bore.

No electro fusion fittings shall be used with HDPE unless specific written approval is provided by the City.

2. For force mains, the HDPE pipe shall have the same size or larger inside diameter as the connecting mains unless otherwise noted on the plans; or approved by the City and Engineer.
3. The depth of all directional bores for FDOT roads shall be in accordance with the FDOT permit requirements.

4. The slurry may be recycled for reuse in additional hole opening operations if approved by the City and Engineer or it shall be removed and disposed of at an approved dump site. No fluids shall be allowed to enter any unapproved areas or natural waterways.
5. For directional bores under any surface water (subaqueous) the drilling Contractor must submit a 'frac-out' response plan for review and approval prior to starting the directional bore. During execution of all subaqueous directional bores, the drilling Contractor must have at the site the necessary material, equipment, and manpower to properly respond to a 'frac-out' in accordance with the 'frac-out' response plan. Refer also to Specification 332010 - Directional Drilling.

C. FITTINGS

Pipe, valves, fittings or other items shall be inspected prior to installation, and any items showing a fracture or other defect shall be rejected. Additionally, any pipe or fitting which has received a severe blow that may have caused an incipient fracture, even though not visible, shall also be rejected. When tightening bolts, the Contractor shall bring the gland up toward the flange evenly while maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Tighten all nuts progressively a little at a time. DO NOT over stress bolts to compensate for poor alignment. If effective sealing is not attained at the maximum torque, disassemble the joint and reassemble again after cleaning. Fittings shall be installed in accordance with the manufacturer's printed instructions.

D. RESTRAINTS

Piping shall be restrained in accordance with the NPU Standard Details restraint table. The table is based on a safety factor of 2.0 and takes into account variables such as type of soil, type and depth of the trench, and depth and type of pipe. In addition, the restraints may be supplemented with thrust blocks if approved by the City. The City requires prior approval prior to the use of any thrust blocks. The Engineer shall provide the dimensions of the thrust blocks to the City for use in the approval prior to construction.

E. STORM SEWER CONFLICTS

Force mains that must be installed with less than twelve inches (12") of clearance under storm sewer pipes or structures due to existing physical limitations that prohibit deflection or directional drilling, require construction of a bridging structure that is acceptable to the City to support the storm sewer prior to installation of the force main. The force

main pipe section under the storm sewer pipe or structure shall be replaced with a single 20 LF stick C-900 DR-14 pipe centered under the storm sewer pipe or structure. The Contractor shall submit details of the proposed bridging structure and force main pipe installation to the City and Engineer for review and approval prior to the start of construction at the conflict location.

F. WATER MAIN CROSSING

All force mains shall cross water mains at ninety (90) degrees and with a minimum angle of forty-five (45) degrees.

3.2 TESTING MAINS AND TAPPING SLEEVES

The Contractor shall perform hydrostatic testing of all wastewater force mains, as set forth in the following, and shall conduct said tests in the presence of representatives from the City and/or Engineer, with two (2) days advance notice provided.

All pressure tests shall be in accordance with AWWA C-600, latest revision. A pressure test shall be required for all installations of force mains and all appurtenances. Pressure testing shall not exceed 1,500 linear feet unless otherwise approved by the City and Engineer.

A. PRESSURE TEST

1. PIPE

Hydrostatic testing shall be performed at 150 percent of the maximum operating pressure of the tested system, or connected sewage pump shut-off pressure, or 100 psi for 18-inch diameter pipe and less, or 50 psi for 20 inch diameter pipe and larger, whichever value is greater. The testing procedure shall continue for an uninterrupted period of not less than two (2) hours. Testing shall be in accordance with the applicable provisions as set forth in Section 4 of AWWA Standard C-600. The allowable rate of leakage for DI piping shall be less than the number of gallons per hour determined by the following formula:

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

Where: L = allowable leakage in gallons per hour
S = length of pipe tested in feet
D= nominal diameter of the pipe in inches
P= average test pressure during the leakage test in pounds per square inch, gauge

Calibrated test equipment shall be on site to verify the loss of water during the testing period. The allowable leakage for PVC and HDPE piping shall be 90 percent of the value calculated above.

Should the test fail, the Contractor shall accomplish necessary repairs and the test repeated until within the established limits. The Contractor shall furnish the necessary labor, water, pumps, gauges and all other items required to conduct the required force main testing and shall perform the necessary system repairs required to comply with the specified hydrostatic test.

2. TAPPING SLEEVES

All force main tapping sleeves shall be hydrostatically pressure tested in accordance with the latest revision of AWWA C-600. The test shall be conducted at 150 psi for a period of two (2) hours. No loss of pressure is allowed.

3. PROCEDURES

Each section of pipe between valves, between the tapping sleeve and the pipe, and/or the valve and the tapping sleeve shall be slowly filled with water from a safe source, and the specified test pressure shall be applied by means of a water pump in a manner satisfactory to the City. In the case of testing a pipe where valves do not exist, the Contractor shall plug the end of the line as approved by the City. The pump, pipe, and/or tapping sleeve connections, gauge, and all necessary apparatus shall be furnished by the Contractor and shall be approved by the City and/or Engineer prior to conducting any test. All necessary pipe taps for testing shall be made by the Contractor as approved by the City. The City may request testing of isolated portions between valves within the test section if a portion of that main has critical components such as multiple fittings at an extreme deflection. The Contractor shall be responsible to remove any pipe taps installed for this purpose upon completion of the test as approved by the City.

Pressure testing shall be measured from sample points and/or blow-off assemblies for force main pressure tests. The City shall witness all tapping sleeves and force main pressure tests.

END OF SECTION