

# SEWAGE FORCE MAINS – SECTION 429

## 1. GENERAL

### 1.1. SCOPE OF WORK:

The Contractor shall furnish and install a sewage force main system, complete, tested and ready for operation. The work shall also include such connections, reconnections, temporary service and all other provisions in regard to the existing operation and modification as is required to perform the new work. All references to Industry Standards (ASTM, ANSI, AWWA, etc.) shall be to the latest revision unless otherwise stated. Only those materials included in the JEA Water and Sewer Standards Manual shall be installed. All materials shall be new unless specifically called for otherwise. *For the supply of domestic water during construction, the contractor shall utilize a JEA meter assembly (meter & back flow device). In most cases, domestic water will be supplied from a jumper line between the potable water main, through a JEA meter assembly and to the new sewer force main. Un-accountable water quantities shall be minimized where possible.*

### 1.2. PROJECT SCHEDULE AND COOPERATION:

The project schedule shall be established on the basis of working a normal work schedule including five days per week, single shift, eight hours per day or four days per week, single shift, ten hours per day. Unless approved otherwise by JEA, normal or general items of work, such as leakage and pressure testing, density testing and final inspections, shall be scheduled during the normal work schedule. Due to operational and manpower limitations on the JEA systems, JEA will require the contractor to perform work outside of the normal work schedule. These operational and manpower limitations, including but not limited to, line filling and flushing operation, tie-in work (cut-in work or other work) and other phases of the work which may impact the continued (non-interruptible) service to existing JEA customers. The contractor shall plan and anticipate the cost impact of these system limitations and provide such work or services at no additional cost to JEA.

### 1.3. SHOP DRAWING SUBMITTALS:

Actual catalog data, brochures and descriptive literature will not be required for items of standard usage which meet the requirements of Section 429 of the JEA Water and Sewer Standards Manual. Any specialty item not shown in this manual will require a complete shop drawing submittal. The Engineer may at any time require the Contractor to provide a complete detailed shop drawing submittal for any material which may, in the Engineer's opinion, not be in compliance with the JEA Water and Sewer Standards.

### 1.4. AS-BUILT DRAWING:

As-built drawings (to be utilized in future utility locate work) are required on all water, sewer, force main, pump station and reclaimed water projects, including projects for JEA, City of Jacksonville, JTA, DOT, private developments (utilities to be dedicated to JEA), and other City Authorities, etc. As-built drawings shall be in accordance with specification Section 501, entitled "As-built Drawings". As built drawings shall be reviewed and approved by JEA. The cost to provide as-built drawings shall be included as part of the related work requirements or general conditions for the utility work.

## 1.5. WARRANTY:

The Contractor shall provide to JEA a one (1) year unconditional warranty after substantial project completion or acceptance or any designated portion thereof. The warranty shall include materials and installation and shall constitute complete replacement and delivery to the site of materials and installation of same to replace defective materials or defective workmanship with new materials/workmanship conforming to the specifications.

## 2. MATERIALS

All material shall be free from defects impairing strength and durability, shall be of the best commercial quality for the purpose specified, and shall have structural properties sufficient to safely sustain or withstand strains and stresses to which it is normally subjected and be true to detail.

### 2.1. PIPE:

Pipe for force main lines in sizes up to and including 48 inches shall be ductile iron, polyvinyl chloride (PVC), fiberglass or high density polyethylene (HDPE), as shown on the drawings and as herein specified. Pipe for force main lines larger than 48 inches shall be fiberglass or ductile iron as shown on the drawings and herein specified. Pipe to be used as a casing in sizes 4 inches and larger shall be welded steel pipe as shown on the drawings and as herein specified. Pipe to be installed underground shall be push-on joint or mechanical joint type. Pipe installed on bridges, piles or other above ground installations shall be push-on restrained joint utilizing fast-grip gaskets (American Pipe), Field Lok gaskets (U.S. Pipe), restrained mechanical joint ductile iron pipe or flanged ductile iron pipe as described in these specifications (Bell and rod restraints shall not be used unless approved otherwise by JEA). PVC pipe shall not be used in above ground applications. Underground pipe shall be furnished in nominal 18 or 20 foot laying lengths unless indicated otherwise on the drawings. Pipe shall be cut to length as required to fit installation conditions. PVC or HDPE piping shall not be utilized on bridges or other above ground applications. Pipe sizes and applications shall conform to the following chart.

PIPE	PIPE SIZE	JOINT TYPE	APPLICATION
Ductile Iron	4 inches and larger	Mechanical joint, push-on joint, flanged joint, ball joint, etc.	above ground or exposed
PVC DR18	4 inches and larger	Push-on joint	below ground
PVC DR 25	16 inches and larger	Push-on joint	below ground
PVC (Sch. 40)	3 inches and smaller	Solvent Weld	below ground
PVC (Sch. 80)	3 inches and smaller	Solvent Weld	below ground
Polyethylene (HDPE)	2 inches and larger	Fused	below ground
Fiberglass Reinforced Polymer Mortar Pipe	24 inches and larger	Bell-spigot joint	above or below ground
Steel	4 inches and larger	Welded	casing only

**2.1.1. Ductile Iron Pipe:**

Ductile iron pipe wall thickness and pressure class shall conform to ANSI Specification ANSI A21.50 (AWWA C150) and ANSI A21.51 (AWWA C151) with pressure class 150 as a minimum. Pipe shall also be certified by ISO 9000 by an accredited registrar. Each length shall be clearly marked with the name of the manufacturer, location of the foundry, pressure rating, thickness or pressure class, nominal pipe diameter, weight of pipe without lining and length. All pipe furnished by the manufacturer shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. All ductile iron pipe shall be externally coated and internally lined as specified in this section. All ductile iron pipe shall be color coded green by field applying a 3 inch wide utility marking tape (tape with adhesive backing), along the crown of the pipe barrel. For large diameter pipe (12 inches and greater), a filler gauge may be utilized during the installation to check for rolled gaskets.

**2.1.2. Polyvinyl Chloride Pressure Pipe:**

Pipe shall be virgin polyvinyl chloride (PVC) pipe for force main and shall have a bell type coupling with a thickened wall section integral with the pipe barrel in accordance with ASTM D3139. Elastomeric seals shall meet ASTM F477 **and shall be attached to the bell utilizing glue (AWWA and manufacturer's approved type) or rieber ring**. The pipe material shall be clean, virgin, National Sanitation Foundation No. 14 approved, Class 12454-A or 12454-B PVC compound conforming to ASTM resin specification D1784. Each length shall be clearly marked with the name of the manufacturer, location of the plant, pressure rating, nominal pipe diameter and length. Storage and handling of PVC pipe shall be in accordance with chapter 6 of AWWA Manual M23. All PVC DR 18 and DR 25 pipe shall be green.

**2.1.2.1. PVC 1120, Class 100, DR 25 Pipe:**

Pipe shall conform to AWWA Standard C905 for 14 inch through 36 inch pipe. Pipe is to be manufactured to ductile iron pipe equivalent outside diameters.

**2.1.2.2. PVC 1120, Class 150, DR 18 Pipe:**

Pipe shall conform to AWWA Standard C900 for 4 inch through 12 inch pipe, and AWWA Standard C905 for 14 inch through 36 inch pipe. Pipe is to be manufactured to ductile iron pipe equivalent outside diameters.

**2.1.2.3. PVC 1120, Schedule 40 and Schedule 80 Pipe:**

Pipe shall conform to ASTM D1784 and D1785. **Green color pipe is preferred, but if not available then white or grey color pipe may be utilized with the addition of 3 inch wide (minimum) non-detectable utility tape (tape with an adhesive backing)**. Pipe is to be manufactured to I.P.S. (Steel) Standard Pipe equivalent outside diameters. Pipe shall be marked NSF-PW approved. For the assembly of the pipe, the contractor shall utilize pipe cleaner and glue (solvent weld) as recommended by the pipe manufacturer.

2.1.3. Fiberglass Reinforced Polymer Mortar Pipe:

2.1.3.1. Products:

2.1.3.1.1. Materials:

2.1.3.1.1.1. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

2.1.3.1.1.2. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

2.1.3.1.1.3. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.

2.1.3.1.1.4. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used shall not detrimentally affect the performance of the product.

2.1.3.1.1.5. Elastomeric Gaskets: Gaskets shall be supplied by qualified gasket manufacturers and be suitable for the service intended.

2.1.3.1.2. Manufacture and Construction:

2.1.3.1.2.1. Pipes: Manufacture (CCFRPM) pipe by the centrifugal casting process to result in a dense nonporous, corrosion-resistant, consistent composite structure. The pipe nominal pressure class (PN) shall be equal to or greater than the maximum sustained operating pressure of the line (PN 150 minimum). The maximum transient (operating plus surge) pressure of the line shall not exceed the pipe nominal pressure class by more than 40%. No exterior pipe color required.

2.1.3.1.2.2. Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D4161. Tie-ins, when needed, may utilize gasket-sealed mechanical couplings. Restrained joints may be provided by reinforced fiberglass materials as per the pipe manufacturer's recommendation and as approved by JEA. Other restraint devices must be approved by JEA (follow the D.I.P. Restraint Joint Schedule, at a minimum).

2.1.3.1.2.3. Fittings: Flanges, elbows, reducers, tee, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. If approved by JEA, properly protected standard ductile iron fittings may also be used. Unbalanced thrust forces shall be restrained with thrust blocks, axial restraint systems or other suitable methods as approved by JEA. Fiberglass tees, wyes, laterals, or other similar fittings shall be fully encased in reinforced concrete designed to withstand the pressure forces. The pipe manufacturer shall be consulted during the design of the restraint system.

2.1.3.1.2.4. Acceptable Manufacturer: HOBAS Pipe USA, Inc., or JEA approved equal.

2.1.3.1.3. Dimensions:

2.1.3.1.3.1. Diameters: The actual outside diameter (18" to 48") of the pipes shall be in accordance with AWWA C950. For other diameters, OD's shall be per manufacturer's literature.

2.1.3.1.3.2. Lengths: Pipe shall be supplied in nominal lengths of 20 feet. Actual laying length shall be nominal +1, -4 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

2.1.3.1.3.3. Wall Thickness: The minimum wall thickness shall be the stated design thickness. For pipe sizes 27 inch thru 36 inch utilize PN 150 minimum. For pipe sizes larger than 36 inch utilize PN 100 minimum.

2.1.3.1.4. Testing:

2.1.3.1.4.1. Pipes: Pipes shall be manufactured in accordance with the applicable standard.

2.1.3.1.4.2. Joints: Coupling joints shall meet the requirements of ASTM D4161.

2.1.3.1.4.3. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 36 psi.

2.1.3.1.4.4. Tensile Strength: Pipe hoop tensile strength for pressure pipe shall be verified as specified in applicable standard (ASTM D3754 or AWWA C950) or by random burst testing at the same sampling frequency. All pipes shall be capable of withstanding a test pressure of two (2) times the maximum sustained operating pressure of the

line without leaking or cracking. This performance shall be verified as agreed between the buyer and seller.

2.1.4. Steel Casing Pipe:

Pipe to be used as a casing shall conform to either ASTM Standard A139 for "Electric Fusion (arc) Welded Steel Pipe" with minimum yield strength of 35,000 psi or "API Specification API-5LX, Grade X-42 Welded Steel Pipe". Wall thickness shall meet the requirements of the latest Revision of the American Railway Engineering Association Manual of Recommended Practice or the Florida Department of Transportation Standard Specification for Road and Bridge Construction, as applicable. For street uses which are not DOT or railroad, use DOT casing thickness unless otherwise indicated by Engineer. All pipe furnished by the manufacturer shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Full pipe length shall be provided. No short pipe lengths less than 8 feet long will be allowed unless approved by JEA. The pipe ends shall be tapered where welding is required.

2.1.5. High Density Polyethylene (HDPE) Pipe:

See "Horizontal Directional Drilling" (Section 750), for technical specifications for this product and associated construction standards.

2.2. **FITTINGS:**

Fittings shall have joints that match the type of pipe furnished except as follows or as otherwise specified. PVC fittings 3 inch and smaller shall be solvent weld. Fittings 4 inches and larger on push-on joint pipe installed underground shall be ductile iron with restrained mechanical joint ends or PVC with restrained push-on bell type joint pressure rating to match the pipe, at a minimum. Fittings 4 inches and larger installed above ground shall be ductile iron with flanged ends or restrained joints unless shown otherwise on the drawings. Large tee fittings (14 inches and larger) shall be ductile iron only.

2.2.1. Ductile Iron Fittings:

Ductile iron fittings shall have a minimum working pressure of 250 psi. Fittings shall conform to ANSI Specification A21.10 (AWWA C110), A21.11 (AWWA C111), A21.15 (AWWA C115) and/or A21.53 (AWWA C153). Fittings shall also be certified by ISO 9000 by an accredited registrar. Compact fittings shall normally be installed. Long body fittings shall be used where the drawings specifically call for long body fittings, where compact fittings are not available, or at the option of the Contractor when the laying length is not controlled by compact fitting patterns. All fittings shall be UL/FM approved and shall conform to NSF Standard 61 as applicable. All fittings furnished by the approved manufacturer shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Fittings shall have cast on them the pressure rating, nominal diameter of openings, manufacturer's name, foundry location, plant code and degrees or fraction of the circle. Cast letters and figures shall be on the outside body of the fitting. The JEA may require random ductile testing of manufacturer's fittings. All ductile iron fittings shall be externally coated and internally lined as specified in this section. Ductile iron welded-on outlets are not acceptable. In lieu of ductile tee/fittings, a tapping sleeve may be utilized on 24 inch and larger (D.I.P or PVC) pipe for outlets 12 inches and smaller.



**2.2.2. Polyvinyl Chloride Fittings:**

Fittings that are 3 inch and smaller may be PVC with push-on bell type joint or PVC with solvent weld joints as outlined above. Fittings that are 4 inches and larger shall be restrained push on bell joint. Restraints shall be in accordance with this specification regarding installation and material. The fittings shall conform to the appropriate sections of these specifications for PVC pipe and PVC pipe joints.

**2.2.2.1. PVC 1120, Class 150, DR 18 Fittings:**

PVC fittings 4 inch through 12 inch may be used with PVC C900 pipe. Fittings shall be PVC injection molded, made from materials meeting or exceeding the requirements of cell class 12454-B material as defined in ASTM D1784. All PVC fittings must comply with, or exceed, AWWA C907. All fittings must be designed to the pressure class of DR18, with a pressure rating of 150 psi and a 2.5 to 1 factor of safety. Virgin materials only shall be used in the manufacture of PVC pressure fittings. These fittings must have UL-FM approval and shall comply with or exceed all ASTM Standards for PVC fittings. All fittings must have NSF-61 approval. The elastomeric gasket shall comply with the requirements specified in ASTM F477 [and shall be attached to the bell utilizing glue \(AWWA and manufacturer's approved type\) or rieber ring.](#)

**2.2.2.2. PVC Fabricated Fittings (14" And Larger):**

Fittings (except TEE fittings) shall be fabricated from PVC pipe meeting the requirements of AWWA C-905. The component pipe segments and bonds between fittings shall be free from voids, cracks, inclusions and other defects. The joining surfaces of the spigots and bells shall be free from imperfections that could cause leaks. When component segments are joined using solvent cement, the procedure shall conform with the standard practice for making pressure joints outlined in ASTM D2855. Reinforcement may be applied and permanently bonded to the outside surfaces of the fitting. Reinforcement overwrap shall be in compliance with the appropriate sections of AWWA C-905. Tee fittings must be ductile iron. The elastomeric gasket shall comply with the requirements as specified in ASTM-F472 [and shall be attached to the bell utilizing glue \(AWWA and manufacturer's approved type\) or rieber ring.](#) Fittings shall be tested in accordance with the appropriate sections of AWWA C-905. All fittings shall include the following markings: nominal size, PVC pressure rating, pressure class and manufacturer name and/or trademark. Fittings color shall be green or white.

**2.2.2.3. PVC 1120, Schedule 40 and Schedule 80 Fittings:**

Schedule 40 and schedule 80 fittings shall have solvent weld joints and shall be in accordance with ASTM D2672 and white, grey or green color.

**2.2.2.4. Polyethylene Fittings:**

See "Horizontal Directional Drilling", (Section 750), for technical specifications for this product and associated construction standards.

**2.2.3. Non-Standard Fittings And Wall Castings:**

Fittings having nonstandard dimensions and cast specifically for this project shall be of approved design. They shall be manufactured to meet the requirements of the same specifications and shall have the same diameter and thickness as standard

fittings, but their laying lengths and types of ends shall be determined by their positions in the pipelines and by the particular piping to which they connect. Wall castings shall be of the size and types indicated on the drawings. Flanges, facing, and drilling shall conform to the 125-pound American National Standard. Flanges shall be drilled and tapped for studs. Other dimensions shall be substantially equal to corresponding parts of standard bell and spigot fittings.

### 2.3. JOINTS:

Type of joint used shall meet the following specifications or be approved by the Engineer prior to installation. Joints shall be made in accordance with approved printed instructions of the manufacturer, and shall be absolutely watertight.

#### 2.3.1. Mechanical Joints:

All jointing materials for mechanical joints shall be provided by the pipe and/or fitting manufacturer. Material assembly and bolting shall be in accordance with ANSI Specification A21.11 (AWWA C111). All glands shall be made of ductile iron only.

#### 2.3.2. Push-On Joints:

##### 2.3.2.1. Ductile Iron:

Push-on joints shall be in accordance with ANSI Specification A21.11 (AWWA C111). All joint material shall be provided by the pipe manufacturer and installation shall be in accordance with the manufacturer's recommended practice.

##### 2.3.2.2. Polyvinyl Chloride (PVC):

PVC pipe joints shall be the manufacturer's standard push-on bell type with rubber sealing ring in accordance with ASTM D3139. Elastomeric gaskets shall conform to ASTM F477.

#### 2.3.3. Ball And Socket Joints:

Where subaqueous joints are indicated, joints shall be bolted or boltless flexible ball and socket joints conforming to the pressure and thickness requirements of ANSI A21.10 (AWWA C110) and ANSI A21.51 (AWWA C151) and shall be capable of providing a maximum deflection of fifteen degrees at each joint. Joints and gasket material shall be manufacturer's standard. The specific type joint shall be as shown on the drawings and/or as approved by the Engineer. Installation shall be in accordance with the manufacturer's recommended practice.

#### 2.3.4. Flanged Joints:

Ductile iron flanged joints shall conform to ANSI A21.10 (AWWA C110) and ANSI A21.15 (AWWA C115). Flanges shall be in accordance with ANSI Specification B16.1, Class 125 with any special drilling and tapping as required to insure correct alignment and bolting. Screwed flanges shall be screwed in tight at the foundry by machine before they are faced and drilled. Flanges for flanged joints and flanged specials shall be integrally cast at right angles to the axis, accurately faced, and drilled smooth and true. Gaskets shall be rubber ring type, cloth inserted, minimum thickness of 1/8 inch and shall be used on all flanges. The entire gasket, including the retainer and sealing ring, shall be one continuous piece. Retainers glued together will not be accepted. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI standard as the flanges. Bolts and nuts shall be of Grade B conforming to the ASTM Specifications for steel machine bolts and nuts and tap bolts, designation A307. Bolt studs shall be of the same



quality as machine bolts. Bolts shall be tightened so as to distribute evenly the stress in the bolts and bring the pipe in alignment. The Contractor shall provide suitable filling rings where the layout of the flange piping is such as to necessitate their use. In materials, workmanship, facing and drilling, such rings shall conform to ANSI B16.1 Class 125.

2.3.5. Machined Surfaces:

Machined surfaces shall be cleaned and coated with a suitable rust preventive coating at the shop immediately after being machined.

2.3.6. Steel Casing Pipe Joints:

Steel casing pipe joints shall be electric fusion (arc) welded by operators whose qualifications meet the requirements of the American Welding Society Standard procedures and in conformance with AWWA C206. For field welds, the joints to be welded shall be tapered (approximately 45 degree taper).

2.3.7. Polyvinyl Chloride Solvent Weld Joints:

Pipe joints for schedule 40 or schedule 80 pipe shall be solvent weld joints. The solvent cement shall comply with ASTM D2564. The joint shall be made in accordance with ASTM D2855. The joint shall conform to ASTM D2672.

2.3.8. Restrained Joints:

2.3.8.1. Restrainers:

The restrainer shall be manufactured of ductile iron and shall meet or exceed all the requirements of ANSI A21.11 (AWWA C111) and ASTM A536. The restrainer system shall provide anchoring ductile iron pipe and fittings, valves and PVC pipe to mechanical joint pipe or fittings, or bell to spigot PVC pipe joints. The restrainer shall accommodate the full working pressure rating of the pipe plus surge allowance. In the assembly of the restraint device, the contractor shall tighten the bolts to the correct torque range as recommended by the restraint manufacturer. The restrainers shall be painted black for ductile iron pipe and painted red for PVC pipe applications. Restrainers shall be properly stored to minimize sand and debris build-up. Specifically the twist-off-screws and associated threads shall be clean (free of sand) prior to installation.

2.3.8.2. Restrainers Specifically For Ductile Iron Pipe:

Joints may be restrained by utilizing a joint restraint gasket which includes a stainless steel locking segments vulcanized into the rubber gasket. The gasket shall be rated for operating pressures up to 250 psi based on the performance requirements of ANSI/AWWA C111/A21.11, Standard for Rubber – Gasket Joints of D.I.P. & F. Pipe Manufacturer's restraints for joint restraints designed for operating pressures of up to 250 psi minimum will also be acceptable if approved by JEA. Acceptable: Fast-grip gaskets (American Pipe), Field-Lok gaskets (U.S. Pipe) or JEA approved equal.

2.3.9. Flange Adapters:

Flange adapters shall be ductile iron manufactured to ASTM A536 standards. Bolt circles and bolt holes shall meet ANSI B16.1 for 125 pounds. Adapter flanges shall meet or exceed all test requirements of AWWA C900, ASTM D2241 and ASTM D1599.

**2.3.10. Pipe Couplings:**

The Contractor shall furnish and install pipe couplings as required to complete the work. Pipe couplings used to join two pieces of ductile iron pipe or PVC pipe shall be sized to match the outside diameter of the pipeline. Transition couplings shall be used to join pipes of different outside diameters. The coupling sleeve shall be manufactured of ductile iron conforming to ASTM A536 and be coated with 14 mils of epoxy. The bolts shall be manufactured of a metal of high corrosion resistance and shall conform to ANSI 21.11 (AWWA C111). Gaskets shall be wedge-type and manufactured of virgin SBR for water and sewer service. The installation of all couplings shall be in accordance with manufacturer's recommendations. Couplers and adapters for polyethylene pipe shall be brass conforming to AWWA C800 and shall be female IPT, pack joint or compression nut.

**2.3.11. Full Circle Repair Clamps:**

Full circle repair clamps shall have type 304 stainless steel shells, lugs, bolts, nuts and washers as per ASTM A193, A194, A240, or shall have type 304 stainless steel shells per ASTM A240, ductile iron lugs as per ASTM A536, and 304 stainless steel bolts, washers and nuts. Gaskets for both types shall be virgin SBR as per ASTM D2000 for water service. **Minimum lengths shall be 7½" long for 6" nominal and smaller pipe, 12" long for 8" – 12" nominal pipe and 20" long for pipes larger than 12" nominal pipe.**

**2.3.12. Expansion Joint Fitting:**

Flexible expansion joints shall be installed in the locations indicated on the drawings and shall be manufactured of ductile iron. The type, location and quantity of expansion joint fittings shall be specifically designed by the design engineer and shown on the construction drawings. The expansion joint shall be designed to protect the pipe main against damage from thermal linear expansion. Linear expansion joints shall be factory-set for 50% expansion/50% contraction. The expansion joint may include an integral ball and socket type flexible joint. The fitting shall be lined with a minimum of 15 mils of fusion-bonded epoxy. The expansion joint fitting shall be pressure tested to 350 psi (250 psi for 30-inch and larger). **Acceptable manufacturers include EBAA Iron, Star or approved equal.**

**2.4. CORROSION PROTECTION FOR DUCTILE IRON PIPE:****2.4.1. Interior Lining:**

The interior of all ductile iron pipe and fittings shall be furnished with an approved amine cured novalac epoxy coating. Acceptable coatings include protecto 401 ceramic epoxy, SP 2000 ceramic epoxy, poly bond plus or JEA approved equal.

**2.4.1.1. Lining Material:**

The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. The lining material shall comply with the following properties:

2.4.1.1.1. A permeability rating of 0.00 when tested according to the procedure described in Method A of ASTM E96-93, Procedure A with a test duration of 30 days.

2.4.1.1.2. The following test must be run on coupons from factory lined Ductile Iron Pipe.

2.4.1.1.2.1. ASTM B 117-85 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.

2.4.1.1.2.2. ASTM G95-87 Cathodic Disbondment (1.5 volts@ 77°F) – Results to equal no more than 0.5mm under-cutting after 30 days.

2.4.1.1.2.3. Immersion Testing rated using ASTM D714-87.

2.4.1.1.2.3.1. 20% Sulfuric Acid – No effect after two years.

2.4.1.1.2.3.2. 140°F-25% Sodium Hydroxide – No effect after two years.

2.4.1.1.2.3.3. 160°F Distilled Water – No effect after two years.

2.4.1.1.2.3.4. 120°F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.

2.4.1.1.3. Abrasion Resistance – Less than 4 mils loss after one million cycles on a  $\pm 22.5^\circ$  sliding aggregate slurry abrasion tester using a sharp natural siliceous gravel with a particle size between 2mm and 10mm.

2.4.1.2. Application:

2.4.1.2.1. Applicator:

The lining shall be applied by a competent firm, who has been certified acceptable by the manufacturer with a successful history of applying linings to the interior of ductile Iron Pipe and Fittings.

2.4.1.2.2. Surface Preparation:

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas where oil or grease is present, or any substance which can be removed by solvent, shall be solvent cleaned using the guidelines outlined in DIPRA-1 Solvent Cleaning. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc, are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface. Any area where rust reappears before lining must be re-blasted. Abrasive blasting of previously lined pipe or fitting (including cement lined materials), is not acceptable. Only virgin metal materials will be utilized in the lining process.

2.4.1.2.3. Lining:

Within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils (minimum), normal dry film thickness of the approved lining. No lining shall be applied when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

**2.4.1.2.4. Number of Coats:**

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printer literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

**2.4.1.2.5. Touch-Up & Repair:**

Joint Compound shall be used for touch-up or repair in accordance with liner manufacturer's recommendations.

**2.4.1.3. Inspection and Certification:**

2.4.1.3.1. JEA may require the contractor to provide the following inspection if a quality concern exists in the field.

2.4.1.3.2. Ductile Iron Pipe and Fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPCPA-2 Film Thickness Rating.

2.4.1.3.3. The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired.

2.4.1.3.4. Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

**2.4.1.4. Handling (at the factory and in the field):**

The lined Pipe and Fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. If damaged, the material shall be repaired in accordance with the liner manufacturer's recommendations.

**2.4.1.5. Warranty:**

A one (1) year warranty shall be furnished by the manufacturer on the serviceability of the lining. This warranty shall include but not be limited to, statements that at any time up to the end of the year from the date of project acceptance:

2.4.1.5.1. The lining shall not have disbonded.

2.4.1.5.2. The lining shall not have suffered any appreciable underfilm migration.

2.4.1.5.3. The interior pipe metal, at points of pinholes or holidays, shall not have suffered detrimental deterioration.

2.4.1.5.4. The lining shall have maintained its smooth surface characteristics. The Contractor and/or manufacturer shall not make any exemption or exception to the above stated

conditions or warranty within the limits as stated in this section of these specifications.

2.4.2. Exterior Coating:

All ductile iron pipe and fittings, except as otherwise noted, shall receive an exterior bituminous coating as specified in ANSI A21.51. The finish coating shall be continuous smooth, neither brittle when cold nor sticky when exposed to the sun, and be strongly adherent to the fitting. If the pipe is installed in corrosive soils, then all bolts, nuts, studs and other uncoated parts of joints for underground installation shall be coated with asphalt or coal-tar prior to backfilling. Corrosive soil shall be defined as described in AWWA C105, appendix "A".

2.4.3. Polyethylene Wrap:

In areas where soils are corrosive in nature, ductile iron pipe, fittings, valves and other appurtenances shall be protected with polyethylene wrap or tubing. Corrosive soil shall be defined as described in AWWA-C105, appendix "A". The Contractor shall furnish and install polyethylene tube or wrap for ductile iron pipe at the locations shown on the construction drawings or as directed by JEA.

2.4.3.1. Material:

The polyethylene material shall meet or exceed the requirements of AWWA C105 in all respects. The wrap shall be virgin, high density polyethylene, 4 mils thick minimum cross laminated type or 8 mils linear low density tape. The polyethylene wrap shall include industrial standard repeatable message (green color).

2.4.3.2. Installation:

Although not intended to be a water-tight enclosure, the polyethylene shall prevent contact between the pipe and the surrounding backfill. Installation shall be done according to one of the methods described in Section 5.4 of AWWA C105, subject to approval by the engineer and the manufacturer.

2.4.4. Marking For Ductile Iron Pipe and 2" PVC Pipe:

All ductile iron pipe and 2" PVC pipe below ground shall be marked with a 3 inch wide (minimum), non-detectable utility marking tape (tape with an adhesive backing). The utility marking tape shall be installed on the pipe at the 12:00 o'clock position. Tape shall be 4 mil (minimum) ASTM D2103 thickness constructed for prolonged use underground, meet the industry standards (APWA) color code, tensile strength of 2750 psi (ASTM D882), and industrial standard repeatable message. All ductile iron pipe above ground (including bridge crossing) shall be color labeled "SEWER" stenciled in the center of each joint of pipe utilizing an oil based paint. Stenciled lettering shall be 4" (minimum), high lettering and be green color. All fittings (above ground or below ground) shall be labeled "SEWER", or marked with green paint (6 inch diameter solid circle, minimum), within 48 hours after site delivery. By properly marking the ductile fittings, this will assure that only sewer fittings will be utilized on the force main system.

2.5. PIPING SUPPORTS:

2.5.1. The Contractor shall furnish and install all supports necessary to hold the piping and appurtenances in a firm, substantial manner at the lines and grades indicated on the drawings or as specified.

2.5.2. Piping within pumping stations shall be adequately supported from floors, walls, ceilings or beams. Supports from the floor shall be by approved saddle stands or suitable concrete piers as indicated or approved. Pipe saddles shall be shaped to fit the pipe with which they will be used and shall be capable of screw adjustment. Concrete piers shall conform accurately to the bottom one-third to one-half of the pipe. Piping along walls shall be supported by approved wall brackets with attached pipe rolls or saddles or by wall brackets with adjustable hanger rods. For piping supported from the ceiling, approved rod hangers of a type capable of screw adjustment after erection of the piping and with suitable adjustable concrete inserts or beam clamps shall be used. If required, piping supports shall be placed so as to provide a uniform slope in the pipe without sagging. Supports shall be located wherever necessary, and in no case shall they exceed 8 feet on centers for ductile iron pipe and 4 feet on centers for PVC pipe.

2.5.3. Casing Spacers:

Casing spacers shall be a two piece prefabricated unit by a single manufacturer. All casing spacers in a single casing pipe crossing shall be by the same manufacturer. Casing spacers shall have a shell made from either 304 stainless steel, 14 gauge mild steel which has been heat fusion coated with PVC plastic, (PVC coating shall be .01 inch thick over the entire band including the runner studs) or high density polyethylene. Casing spacers on 16 inch and smaller carrier pipe shall have 8 inch wide steel bands and casing spacers on 18 inch and larger carrier pipe shall have 12 inch wide steel bands, except high density polyethylene spacers shall have high density polyethylene bands. All casing spacers for 14 inch and smaller pipe size shall have four 10 gauge or 14 gauge steel risers with runners and casing spacers for 16 inch and larger pipe shall have six 10 gauge or 14 gauge steel risers with runners (two top and four bottom), except high density polyethylene spacers shall have one riser for every diameter inch of carrier pipe. The runners (risers) shall be either glass reinforced plastic, UHMW polymer or high density polyethylene. All nuts, bolts and washers shall be 304 stainless steel. All risers over 2 inches in height shall be reinforced. Wooden skids are not an acceptable alternate.

2.6. LOCATE WIRING:

Locate wire shall be installed on all PVC, ductile iron and HDPE force main piping. No wire shall be installed on above ground installations. Locate wiring shall be 10 gauge, single strand, UF rated (direct burial), copper wire with 30 mil. (minimum) insulation. The outside color of the wire shall be either white or yellow.



## 2.7. MATERIAL TESTING:

JEA will perform random testing of all materials furnished for conformance to the following standards. The entire product of any manufacturer or of any one plant may be rejected when, in the opinion of JEA, the methods of manufacture fail to secure uniform results acceptable to the requirements of these specifications. Pipe and materials shall be tested in, and for conformity with, the latest editions of the following:

<u>Item</u>	<u>Specifications</u>
<u>Ductile Iron Pipe and Fittings</u>	ANSI A21.50 (AWWA C150)
	ANSI A21.51 (AWWA C151)
	ANSI A21.53 (AWWA C153)
	ANSI A21.40 (AWWA C104)
	ANSI A21.50 (AWWA C105)
	ANSI A21.10 (AWWA C110)
	ANSI A21.15 (AWWA C115)
<u>Polyvinyl Chloride Pipe and Fittings</u>	ASTM D1598
	ASTM D1599
	ASTM D1784
	ASTM D1785
	ASTM D2122
	ASTM D2241
	ASTM D2564
	ASTM D2672
	ASTM D2837
	ASTM D2855
	ASTM D3139
	ASTM F477
	AWWA C900
	AWWA C905
	AWWA C907
<u>Polyethylene Tubing</u>	ASTM D1248
	ASTM D2239
	ASTM D2737
	ASTM D3350
	AWWA C901

## 3. INSTALLATION

## 3.1. REFERENCE POINTS AND LAYOUT:

The Contractor shall be responsible for setting all grade, lines and levels. The Contractor or Contractor's Surveyor will provide centerline of construction and will establish a bench mark. Any reference points, points of intersection, property corners, or bench marks, which are disturbed during construction, shall be restored by a Land Surveyor registered to practice in the State of Florida, and all costs thereof shall be borne by the Contractor. The Contractor shall assume all responsibility for the correctness of the grade and alignment stakes.

**3.2. HANDLING AND CUTTING PIPE:**

Every care shall be taken in handling and laying pipe and fittings to avoid damaging the pipe, scratching or marring machined surfaces, and abrasion of the pipe coating. The lined Pipe and Fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. If damaged, the material shall be repaired in accordance with the liner manufacturer's recommendations. Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. In any pipe showing a distinct crack in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved by JEA, may be cut off before the pipe is laid so that the pipe used shall be perfectly sound. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack. Except as otherwise approved, all cutting shall be done with a power driven cut off saw. All cut ends shall be examined for possible cracks caused by cutting.

**3.3. PIPE INSTALLATION:****3.3.1. General Requirements:**

Force mains shall be constructed of the materials specified and as shown on the drawings. All PVC C900/C905 pipe shall be laid in accordance with AWWA C605. Pipe and fittings shall be carefully handled to avoid damage, and if feasible, while they are suspended over the trench before lowering, they shall be inspected for defects and to detect cracks. Defective, damaged or unsound pipe or fittings shall be rejected. Each section of the pipe shall rest upon the pipe bed for the full length of its barrel, with recesses excavated to accommodate bells and joints. Any pipe which has its grade or joint disturbed after laying shall be taken up and re-laid. Only suitable soils (no heavy clay) shall be utilized in the backfill operation up to 12 inches above the pipe. The maximum joint deflection shall be limited to 80% of the pipe manufacturer's recommendation. All precautions shall be taken to prevent sand or other foreign material from entering the pipe during installation. If necessary, a heavy, tightly woven canvas bag of suitable size shall be placed over each end of the pipe before lowering into the trench and left there until the connection is made to the adjacent pipe. Any time the pipe installation is not in progress, the open ends of pipe shall be closed by a watertight plug or other method approved by the Engineer. Plugs shall remain in pipe ends until all water is removed from the trench. Any sand or foreign material that enters the pipe shall be removed from the pipe immediately. No pipe shall be installed when trench conditions (standing water, excess mud, etc.) or the weather (rain, etc.) is unsuitable for such work, except by permission of the JEA. If, in the opinion of the JEA representative, significant quantities of sand or foreign materials enter the new sewage force main during the construction period, the contractor will be required to flush the system with clean water. The flushing operation, if required, shall be as directed by JEA and shall be accomplished at no additional cost to JEA. The water utilized in the flushing operation shall be provided and paid for by the contractor. Any section of pipe already laid which is found to be defective or damaged shall be replaced with new pipe. The contractor shall coordinate utility locate with Sunshine State One-Call of Florida, Inc. (#800 /432-4770 or web site [www.callsunshine.com](http://www.callsunshine.com)), at a minimum. The use of 90 degree bends 24-inch and larger size shall be avoided if possible (two 45 degree bends or other method is preferred).

**3.3.2. Special Construction Requirements for 24 Inch and Larger PVC Pipe:**

For PVC pipe 24 inch and larger, unless approved otherwise by JEA, a foundation bed of granular material (57 stone) shall be placed under and around all ductile iron fittings and valves for additional support of heavy system components. A foundation bed of granular material shall be provided for all valves 20 inch size and larger. For granular materials, the minimum vertical limit is 12 inches under the fitting or valve, up to 1/3 the overall height of the fitting or valve. The minimum horizontal limits of the granular material shall be 12 inches in all directions beyond the outer edges of the fitting or valve. The compaction of soils below the granular material shall be at 98% of the maximum density. Payment for this work shall be included in the associated fitting or valve unit cost. All spool pieces between 24 inch and larger ductile fittings and valves shall be at least 5 feet long. Where possible, a full joint of pipe (no short pipe lengths) shall be connected to all fittings and valves. No joint deflection shall be allowed at the fittings or valves.

**3.3.3. Pipe Cover:**

The cover over all piping less than 24 inch size shall be a minimum of 30 inches in unpaved areas and 36 inches in paved areas with a maximum of 60 inches, unless approved otherwise by JEA. The cover over all piping 24 inch size or greater shall be 36 inches (paved or unpaved areas), with a maximum of 84 inches, unless approved otherwise by JEA. Cover for pipe under pavement shall be measured from the finished grade. Any reduction in pipe cover will require approval from JEA and the Engineer. Greater depths will be permitted where required to miss obstructions only. Lines shall be located as shown on the drawings. The Contractor shall investigate well in advance of pipe laying any conflicts which may require readjustments in planned locations and advise the Engineer of the results of these investigations so that the Engineer may give instructions as to the modifications required. Refer to Section 408 for backfill and compaction requirements.

**3.3.4. Installation of Iron Piping:**

All iron pipe and fittings shall be laid in accordance with the pipe manufacturer's recommendations and the American Water Works Association Specification AWWA C600.

**3.3.5. Thrust Restraint:**

All non-flanged fittings and valves shall be restrained using one of the following methods:

3.3.5.1. Mechanical restraint at fittings and valves and mechanical restraint along adjacent joints of pipe to a length as specified in the Restraint Joint Schedule (see Plate Nos. S-38A & B), at a minimum.

3.3.5.2. Mechanical joint fittings and valves shall be restrained using an approved restraining device and/or tie rods along adjacent joints of pipe to a length as specified in the following chart. All pipe sizes 3 inches - 8 inches in diameter shall have a minimum of 2 tie rods per joint, pipe sizes 10 inches - 12 inches in diameter shall have a minimum of 4 tie rods per joint and pipe sizes 14 inches - 20 inches in diameter shall have 6 tie rods per joint. To connect tie rods to fitting, offset eyebolts shall be used. Tie rods (core 10 steel or 316 S.S.) shall be ¾ inch diameter steel, threaded as required, installed with a washer and nut (same material as the rod) on either side of the joint.

- 3.3.5.3. The use of thrust blocks shall be limited to situations such as point repair where exposing several joints of pipe is not feasible due to existing ground conditions and also must be used with mechanical joint restraining devices when, in the judgment of the Engineer, the nature and criticality of an installation is such as to require positive assurance of stability. Concrete collars with tie rods may be used on dead end lines at the Contractor's discretion. Concrete used for this purpose shall be 2,500 psi minimum. When applicable, schedule and details for the required thrust blocks are included on the drawings (see Plate No. S-45). The JEA Standard Details show minimum size thrust blocks for use in good soil. Poor soils will require larger thrust blocks.
- 3.3.6. Joint Restraints within Carrier Pipe:  
All joints within steel casing pipe shall be restrained with mechanical restraining devices. End joints shall be tie rodded, with the ends of the rods welded to the end of the casing.
- 3.3.7. Casing Spacer Installation:  
All carrier pipes in casings shall utilize casing spacers installed on the carrier pipe, inside the casing pipe. Casing spacers shall be installed one foot on both sides of each carrier pipe joint, and at ten feet intervals along the carrier pipe for pipe up to 48 inches. For carrier pipes larger than 48 inches, casing placement shall be as recommended by the casing spacer manufacturer. A casing spacer shall also be installed within two feet of each of the ends of the casing pipe.
- 3.4. SEWAGE FORCE MAIN AND WATER MAIN SEPARATION REQUIREMENTS:
- 3.4.1. The minimum separation requirements between sewage force mains and water mains shall be as outlined in specification Section 350 and Detail Nos. S-26 and S-27.
- 3.5. SYSTEM CONNECTIONS:  
All connections and ties to the JEA Sewer System and transfer of services will be performed by the contractor under supervision of the JEA's representative.
- 3.6. FORCE MAIN CONNECTION TO EXISTING MANHOLE:  
Where a new force main is connected into an existing manhole the manhole shall be properly prepared to receive the new force main and repaired or replaced as indicated or specified. Manhole inverts shall be reshaped as required by the new connection to provide a smooth flowing channel of the exact shape of the sewer to which it connects. Manholes shall receive a protective coating as specified in Section 446 of these specifications. An approved gate valve or plug valve must be installed immediately prior to the 45° bends going into the manhole and shall be constructed in accordance with Detail S-18.
- 3.7. TAPPING SLEEVE AND VALVE CONNECTIONS:  
Unless approved otherwise by JEA, tapped connections in the barrel of a pipe shall be less than the diameter of pipe being tapped except 4 inch pipe which may be tapped with a 4 inch tapping sleeve and valve. No taps shall be made within 5 feet of a joint.
- 3.8. PRIVATE SEWER PUMP STATION:
- 3.8.1. If the sewer force main is constructed per JEA standards (i.e.: 4" minimum pipe size, PVC DR-18 Pipe, D.I. Fittings, Iron Valves, etc.) and if these utilities are dedicated and accepted by JEA, all piping within the City R/W will be O&M by JEA.

A JEA approved gate valve (4" minimum) shall be provided at the R/W line (just outside the pump-out box) for all force main piping which exceeds 15 linear feet within the City R/W area. The gate valve at the R/W line is not required on force main piping where the connection (connection at JEA main) is located on the same side of the street as the pump-out box (short side service connection) and consist of 15 linear feet or less within the City R/W area. The Gate Valve or, if no gate valve exist, the R/W line will define the "JEA Point of Service".

- 3.8.2. Sewer Pump-Out Box shall be constructed on private property and located at the R/W line. The Pump-Out box shall provide a pump-out connection including a 4" isolation valve and 4" hose connection (quick disconnect with cap). The preferred construction layout is as shown on JEA plate #S-46. The box may be utilized by JEA or the private owner for maintenance or emergency use. JEA shall have access to the pump-out box at all times. O&M of this box (located on private property) shall be by the private owner.

3.9. PRESSURE AND LEAKAGE TESTS:

The Contractor shall test pipelines installed in accordance with these specifications prior to acceptance of the pipeline by JEA or connecting pipeline to any existing pipeline or facility. All field tests shall be made in the presence of a JEA representative. Except as otherwise directed, all pipelines shall be tested. Pressure testing of PVC and ductile iron pipe shall not include HDPE main piping. Pressure testing of HDPE main piping shall be completed separately with no PVC or ductile iron pipe included in the HDPE test section. Testing of HDPE main piping is detailed in the specification section entitled, "Horizontal Directional Drilling", (Section 750). Pipelines laid in excavation (other than trench excavation), shall be tested prior to the backfilling of the excavation. All piping to operate under liquid pressure shall be tested in sections of approved length. For these tests, the Contractor shall furnish clean water, suitable temporary testing plugs or caps, and other necessary equipment, and all labor required. If the Contractor chooses to pressure test against an existing JEA water main/valve, the new water main must be disinfected prior to connection to the JEA line. JEA will not be responsible for failure of the pressure test due to the existing valve leaking. If positive test results cannot be obtained because the JEA valves will not hold the test pressures, the Contractor shall be required to disconnect from the JEA System and re-test independent of the JEA System and at the Contractor's expense. JEA may elect to furnish suitable pressure gauges. If not, the contractor will provide the pressure gauges. The gauges shall be calibrated by an approved testing laboratory, with increments no greater than 2 psi and a 4 inch diameter face. Gauges used shall be of such size that pressures tested will not register less than 10% no more than 90% of the gauge capacity. Leakage and pressure testing shall be in accordance with applicable AWWA C600 or AWWA C605 and as outlined below.

- 3.9.1. Unless it has already been done, the section of pipe to be tested shall be filled with domestic water of approved quality and all air (or most of the air) shall be expelled from the pipe. Unlike water, entrapped air is compressible and is, therefore, very "explosive" and represents a very high risk of potential damage or even fatalities. Unless approved otherwise by JEA, the contractor shall be responsible for providing and paying for the domestic water utilized in filling the main and, if required, any flushing of the system. If blow offs or other outlets are not available at high points for releasing air, the Contractor shall make the necessary taps at such points and shall plug said holes after completion of the test. The table below is a convenient method to determine the approximate water addition that is required to raise the pressure in the test section from 0 psi to 150 psi with 0% air entrapment. Obviously,

the test section will include some amount of air entrapment. The table below will indicate the severity of the amount of air entrapment in the test section. If the actual field test quantities (additional water amount) is over 4 times greater than the listed amounts, the test section may have severe air entrapment. In this case, the contractor should make additional effort to remove the entrapped air.

- 3.9.2. For mains larger than 20 inch size, it is highly recommended that the contractor profile (line and grade) the main after installation and prior to pressure and leakage test to accurately locate all high points. Field survey instrument (Level equipment) shall be utilized for this task. Blow off valves shall be installed at all high points which offset vertically more than two pipe diameters in length (at a minimum). The contractor shall consult the design engineer on any technical questions or concerns. The table below lists the approximate amount of water which must be added to the pipe to raise the line pressure from 0 psi to 150 psi when no air is present in the pipe.

Pipe Diameter (inch)	Gallons/1000 L.F.
6	0.73
8	1.31
10	2.04
12	2.94
14	4.00
16	5.22
18	6.61
20	8.16
24	11.75
30	18.36
36	26.44
42	35.98

- 3.9.3. Hydrostatic testing shall consist of a combined pressure test and leakage test. Specified test pressures, based on the elevation of the highest point of the line or section under test, and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pipe connection and all necessary apparatus shall be furnished by the Contractor and shall be subject to the approval of the Engineer. All valved sections shall be hydrostatic tested to insure sealing (leak allowance) of all line valves.
- 3.9.4. All piping shall be pressure and leakage tested for a minimum of two hours duration at 150 psi minimum. Pressure tests shall be conducted simultaneously with the leakage test. During the 2 hour test, no pipe will be accepted if pressure loss is greater than 5 psi regardless of the leakage test results. All exposed pipe, fittings, valves and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings or valves that are discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated until it is satisfactory. For new installations, the contractor shall be limited to the number of repair couplings utilized to repair pipe joint leaks. Unless approved otherwise by JEA, the contractor is limited to two repair couplings (i.e., one joint leak) per 1,000



LF installed (same pipe size). Should the actual number of joint leaks exceed the above limit, then JEA may require the contractor to remove and re-install the entire associate main or certain sections of the main at the contractor's expense. Repairing, replacing and retesting shall be done at the Contractor's expense. For new work, "bell joint leak clamps" or similar devices are not acceptable for the repair of leaks at the joint.

- 3.9.5. Leakage tests shall be conducted simultaneously with the pressure tests. At the end of the pressure test, the line will be pumped back to initial test pressure. The quantity of water used to re-pump the line shall be measured and compared to the limitations calculated using the allowable leakage equations below.

Formula No. 1: may be used to determine an allowable leakage amount for PVC pipe, DIP or combination of both. If the actual leakage amount is equal or less than the allowable leakage amount (based upon Formula No. 1), the leakage test is acceptable (test passes and no other calculation are required). If the actual leakage amount is greater than the allowable leakage amount (based upon Formula No. 1), then the allowable leakage amount must be re-calculated based upon the sum total of Formula Nos. 2 and 3. Formula No. 2: shall be utilized to determine the allowable leakage amount for the test section constructed with PVC pipe (based upon the number of rubber gaskets). Formula No. 3: shall be utilized to determine the allowable leakage amount for the test section constructed with ductile iron pipe (based upon the total linear feet). For a test section, which includes both PVC and ductile iron pipe, the allowable leakage amount would be determined by adding the allowable leakage amount based upon Formula No. 2 (for the PVC pipe test section) and Formula No. 3 (for the DIP test section). No pipe installation will be accepted if the actual leakage amount (quantity of make-up water) is greater than the allowable leakage amount (based upon the sum total of Formula Nos. 2 and 3). These 3 formulas meet and exceed the requirements of AWWA C600 and AWWA C605. Pressure and Leakage Test forms for each of these 3 formulas are provided in the back of Section 350.

$$\text{Formula No. 1: (PVC and DIP)} \quad L = \frac{SD P^{1/2}}{148,000}$$

$$\text{Formula No. 2: (PVC only)} \quad L = \frac{ND P^{1/2}}{7,400}$$

$$\text{Formula No. 3: (DIP only)} \quad L = \frac{SD P^{1/2}}{133,200}$$

$P^{1/2} = 12.25$ , where  $P = 150$  psi

In which L is the allowable leakage amount in gallons per hour; S is the length of pipeline tested, in feet (5,000 L.F. Max); D is the nominal diameter of the pipe, in inches; P is the average test pressure during the leakage test, in pounds per square inch, and N is equal to the number of joints (rubber gaskets) in the PVC pipe test section. If test (based on Formula No. 2 and/or No. 3) discloses leakage greater than that specified above, the Contractor shall, at its own expense, locate and repair the defective material and retest until the leakage is within the specified allowance. The total length of pipe within the test section shall not exceed 5,000 linear feet, unless approved otherwise by JEA.

- 3.9.6. In the event a section fails to pass the tests, the Contractor shall do everything necessary to locate, uncover (even to the extent of uncovering the entire section), and replace the defective pipe, valve, fitting or joint. Visible leaks shall be corrected regardless of total leakage. Lines which fail to meet these tests shall be retested as necessary until test requirements are complied with. All testing shall be performed at the Contractor's expense.
- 3.9.7. If, in the judgment of JEA, it is impracticable to follow the foregoing procedures exactly for any reason, modifications in the procedure shall be made with approval; but, in any event, the Contractor shall be responsible for the ultimate tightness of the piping within the above requirement.
- 3.9.8. HDPE: For leakage and pressure testing for high density polyethylene (HDPE, PE), Pipe and fittings, see "Horizontal Directional Drilling" (Section 750), for technical specifications for testing HDPE products. Due to the expansion of HDPE pipe, the pressure testing of HDPE pipe sections must be tested separately from DIP and PVC pipe sections (see Section 750 for clarification).
- 3.10. LOCATE WIRE:
- 3.10.1. Locate Wire Testing Requirements:  
Installed locate wiring shall be tested by the contractor as part of the final inspection procedure, using a certified tester and approved testing equipment. For JEA funded projects (excluding private development projects), the certified tester must be pre-approved by JEA and listed within JEA's RBL listing under 18-H category. The contractor shall request and obtain approval from the JEA field representative (inspector), of the locate wire field testing schedule. The JEA field representative may elect to be present during the testing period. The contractor shall provide the Certified Tester a copy of the project site drawings (as-builts preferred). A tone shall be put on the locate wire. The technician shall trace the entire length of the installed wire and spot paint the location at least at 200-foot intervals along the route. The depth shall be tested at 200-foot intervals. The certified tester shall report (show on drawings), where the pipe/wire has less than the allowable minimum cover or more than the maximum allowable cover (see above for pipe cover limits). For pipe/wire which are installed within the acceptable cover limits, no remarks are required. All lateral stub-outs shall be marked and recorded. A final Locate Wire Report (statement by the certified tester), shall be submitted to JEA for review and approval. The report shall include a signed statement from the certified tester which certifies that all installed wire (where shown on the drawing), was successfully (sounded), traced with no open breaks. The report shall also include a copy of the project site drawings which indicate all field notes, breaks found/repared, depths (if installed outside the acceptable cover limits), and other applicable field remarks by the certified tester. A Certified copy of the report and marked-up drawings shall be furnished prior to final acceptance of the project or as approved otherwise by JEA.  
Definitions: Approved Testing Equipment shall include variable frequency controls, digital depth read-out and tone continuity. The following is a list of approved equipment: -- Dynatel (3M)-2273 Cable /Fault Locator, Metrotech 9800XT, Ditch Witch 950 R/T or JEA pre- approved equal.  
Certified Tester - - A person or company that has been certified by the Manufacturer of the approved testing equipment as proficient in the use of the equipment and has 6 months experience in the use of the equipment including documented proof of past performance.

**3.10.2. Locate Wire Installation:**

Contractor shall furnish and install locate wiring on all force mains (see Detail S-49 for other locate wire requirements). Locate wire must be attached to force mains with duct tape or plastic ties at each side of bell joint or fitting and at 10 foot intervals along pipeline (at a minimum). Locate wire shall be brought to grade within a valve box or Locating Station box, as required, at 475 foot intervals (maximum). Locate wire shall be installed in box and along pipeline as detailed in the JEA Standard Details. Locate wire shall be installed in either the 1:00 or 11:00 position on the pipe. Connection or splices underground which are not inside a locate box (or valve box), shall be prohibited unless it is unavoidable. If an underground connection is unavoidable, then the wire shall be first tied in a knot (to minimize future separation), then the wire ends shall be connected utilizing an electric wire nut, then make the connection (wire nut connections) water tight by using either vinyl mastic tape (4" wide X 0.09" thick by 3M-Scotch 2210) or plastic enclosure (Snap Loc Model LV 9500/951-4 large by TKHP) or JEA approved equal.

**3.11. INSPECTION:**

All pipe and fittings shall be subject to inspection at time of delivery and also in the field just prior to installation. All pipe and fittings which in the opinion of the Engineer do not conform to these specifications will be rejected and shall be removed by the Contractor at the Contractor's expense. An authorized JEA representative must be present for all pressure and leakage testing, connections to JEA's existing lines.

**3.12. STATE HIGHWAY CROSSINGS:**

Permits for all work within the right-of-way of a State Highway will be obtained by the Engineer. The Contractor shall, however, verify the existence of the permit before commencing work in this area. All work related to the State Highway crossing shall be in full compliance with the requirements of the Florida Department of Transportation permit and in accordance with the Florida Department of Transportation Utility Accommodation Guide and standard specifications. Unless otherwise shown on the drawings or specified herein, State Highway crossings shall be made by jacking a steel pipe casing, of the size shown on the drawings and shown in JEA Standard Details, under the highway at the elevations and locations shown. The force main shall then be placed in the casing with approved casing spacers as specified in this section. All joints within carrier pipe shall be mechanically restrained joints. After inspection, the ends of the casing shall be filled with 2500 psi concrete not less than 8-inches thick.

**3.13. RAILROAD CROSSINGS:**

Permits for all work within the railroad right-of-way will be obtained by the Engineer. The Contractor shall, however, verify existence of the permit before commencing work in this area. All work related to the railroad crossings shall be in full compliance with the terms of the permit and AREA Specifications for Pipeline Crossings Under Railway Tracks for Non-Flammable Substances. The force main shall be placed in steel casing pipe under all railroad crossings whether installed by open cutting or jacking and boring. The force main shall then be placed in the casing with approved casing spacers as specified in this section. All joints within carrier pipe shall be mechanically restrained joints. After inspection by the Engineer, the ends of the casing shall be sealed with 2,500 psi concrete not less than 12 inches thick. Upon completion and prior to final acceptance, the Contractor shall place crossing markers of a type acceptable to the Railroad Company at each end of the crossing at the railroad right-of-way.

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