**SECTION 2.1**

**TECHNICAL Specifications FOR**

**FUSIBLE POLYVINYL CHLORIDE (PVC) WATER/WASTEWATER PIPE**

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# PART 1: GENERAL

* 1. **Scope of Work**

This section specifies fusible polyvinyl chloride (PVC) pipe, including standards for dimensionality, testing, quality, acceptable fusion practice, safe handling and storage.

**1.2 Pipe Description**

 Pipe supplier shall furnish fusible PVC pipe as manufactured by Underground Solutions, Inc. or approved equal conforming to all standards and procedures, and meeting all testing and material properties as described in this specification.

**PART 2 QUALITY ASSURANCE**

* 1. **References**

### Unless otherwise stated, the latest editions of the following documents are applicable for this specification:

ANSI/AWWA C110/A21.10 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch, for Water and Other Liquids

ANSI/AWWA C111/A21.11 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C605 Standard for Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

AWWA C651 Standard for Disinfecting Water Mains

AWWA C900 Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100mm Through 300mm), for Water Distribution

AWWA C905 Standard for Polyvinyl Chloride (PVC Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm Through 1200mm), for Water Distribution and Transmission

AWWA M23 AWWA Manual of Supply Practices PVC Pipe- Design and Installation, Second Edition

ASTM C923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals

ASTM D1784 Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds

ASTM D1785 Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120

ASTM D2152 Test Method for Degree of Fusion of Extruded Poly vinyl Chloride (PVC) Pipe and Molded Fittings by Acetone Immersion

ASTM D2241 Polyvinyl Chloride (PVC) Plastic Pipe (SDR‑PR)

ASTM D2665 Polyvinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D3034 Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings

ASTM F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ASTM F679 Standard Specification for Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings

ASTM F1057 Standard Practice for Estimating the Quality of Extruded Polyvinyl Chloride (PVC) Pipe by the Heat Reversion Technique

ASTM F1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

UNI-B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

UNI-PUB-08 Tapping Guide for PVC Pressure Pipe

NSF-14 Plastics Piping System Components and Related Materials

NSF-61 Drinking Water System Components--Health Effects

PPI TR-2 PVC Range Composition Listing of Qualified Ingredients

* 1. **Manufacturer Requirements**
		+ - All piping shall be made from PVC compound conforming to cell classification 12454 per ASTM D1784.
			- Fusible PVC pipe shall be tested at the extrusion facility for properties required to meet all applicable parameters as outlined in AWWA C900, AWWA C905, and applicable sections of ASTM D2241. Testing priority shall be in conformance with AWWA C900 and AWWA C905.
	2. **Fusion Technician Requirements**
		+ - Fusion Technician shall be fully qualified by the pipe manufacturer to install fusible PVC pipe of the type(s) and size(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.
	3. **Warranty**
* A one-year warranty for the pipe shall be included from the Contractor, and shall cover the cost of replacement pipe and freight to project site, should the pipe have any defects in material or workmanship.
* In addition to the standard pipe warranty, the fusing contractor shall provide in writing a warranty for a period of one year for all the fusion joints, including formation, installation, and pressure testing.
	+ - * Unless otherwise specified, the warranty periods shall begin after the Certificate of Acceptance is issued for the contract.
	1. **Pre-Construction Submittals**

 The following product data is required from the pipe supplier and/or fusion provider:

* + - * + Name of pipe manufacturer
				+ Pipe diameter
				+ Dimension Ratio (DR 14 or as per plans)
				+ Pressure Class per applicable standards
				+ Color
				+ Confirmation/ Recommended minimum bending radius
				+ Confirmation/ Recommended maximum safe pull force
				+ Fusion technician qualification indicating conformance with this specification
	1. **Post –Construction Submittals**

 The following as-recorded data is required from the contractor and/or fusion provider to the owner or pipe supplier upon request:

* + - * + Approved data logger device reports
				+ Fusion joint documentation containing the following information:
				+ Pipe diameter and thickness
				+ Machine diameter
				+ Fusion technician identification
				+ Job identification
				+ Fusion joint number
				+ Fusion, heating, and drag pressure settings
				+ Heat plate temperature
				+ Time stamp
				+ Heating and cool down time of fusion
				+ Ambient temperature

# PART 3 PRODUCTS

* 1. **Fusible PVC Pressure Pipe for Potable Water**
		+ Fusible PVC pipe shall conform to AWWA C900, AWWA C905, ASTM D2241 or ASTM D1785 for standard dimensions, as applicable. Testing shall be in accordance with the referenced AWWA standards for all pipe types.
		+ Pipe shall be manufactured with 100% virgin resin. Pipe shall also have 0% recycled plastics content, and shall not consist of any rework compound, even that obtained from the manufacturer’s own production using the same formulation.
		+ Fusible PVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
		+ Fusible PVC pipe shall be manufactured in a standard 40’ nominal length, or custom lengths as specified in the plans.
		+ Fusible PVC pipe shall be blue in color for potable water use.
		+ Pipe shall be marked as follows:

- Nominal pipe size

- PVC

- Dimension Ratio (DR), Standard Dimension Ratio (SDR), or Schedule

- AWWA pressure class, or standard pressure rating for non-AWWA pipe, as applicable

- AWWA standard designation number, or pipe type for non-AWWA pipe, as applicable

- NSF-61 mark verifying suitability for potable water service

- Extrusion production-record code

- Trademark or trade name

- Cell Classification 12454 and/or PVC material code 1120 may also be included

- Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

* 1. **Fusible PVC Pressure Pipe for Wastewater Not Conforming to AWWA C905 Dimensionality**
* Fusible PVC pipe shall conform to AWWA C900, ASTM D2241 or ASTM D1785 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standard.
* Fusible PVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or spigot of any kind incorporated into the pipe.
* Fusible PVC pipe shall be manufactured in a standard 40’ nominal length, or custom lengths as specified.
* Fusible PVC pipe shall be green in color for wastewater use.
* Pipe shall be marked as follows:

- Nominal pipe size

- PVC

- Dimension Ratio (DR), Standard Dimension Ratio (SDR), or Schedule

- AWWA pressure class, or standard pressure rating for non-AWWA pipe, as applicable

- AWWA standard designation number, or pipe type for non-AWWA pipe, as applicable

- Extrusion production-record code

- Trademark or trade name

- Cell Classification 12454 and/or PVC material code 1120 may also be included

- Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

* 1. **Fusible PVC Pressure Pipe for Wastewater Conforming to AWWA C905 Dimensionality**
	+ Fusible PVC pipe shall conform to AWWA C905 standard.
	+ Fusible PVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
	+ Fusible PVC pipe shall be manufactured in a standard 40’ nominal length, or custom lengths as specified.
	+ Fusible PVC pipe shall be green in color for wastewater use.
	+ Pipe shall be marked as follows:

- Nominal pipe size

- PVC

- Dimension Ratio (DR), Standard Dimension Ratio (SDR), or Schedule

- AWWA pressure class

- AWWA standard designation number

- Extrusion production-record code

- Trademark or trade name

- Cell Classification 12454 and/or PVC material code 1120 may also be included

- Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.

* 1. **Fusion Joints**

 Unless otherwise specified, fusible PVC pipe lengths shall be assembled in the field with butt-fused joints. The Contractor shall follow the pipe supplier’s written guidelines for this procedure. All fusion joints shall be completed as described in this specification.

* 1. **Connection and Fittings for Pressure Applications**
		1. Connection:

 Connections shall be defined in conjunction with the coupling of project piping, as well as the tie-ins to other piping systems.

* + 1. Ductile Iron Mechanical and Flanged Fittings

 Acceptable fittings for use with fusible PVC pipe shall include standard ductile iron fittings conforming to AWWA/ANSI C110/A21.10, or AWWA/ANSI C153/A21.53 and AWWA/ANSI C111/A21.11.

* + - * Connections to fusible PVC pipe may be made using a restrained or non-restrained retainer gland product for PVC pipe, as well as for MJ or flanged fittings.
			* Bends, tees and other ductile iron fittings shall be restrained with the use of thrust blocking or other means as indicated in the construction documents.
			* Ductile iron fittings and glands must be installed per the manufacturer’s guidelines.
		1. Sleeve-Type Couplings
			- Sleeve-type mechanical couplings shall be manufactured for use with PVC pressure pipe, and may be restrained or unrestrained as necessary.
			- Sleeve-type couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.
		2. Expansion and Flexible Couplings
			- Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as necessary.
			- Expansion-type mechanical couplings shall be rated at the same or greater pressure carrying capacity as the pipe itself.
		3. Connection Hardware
* Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.
	1. **Connections for Gravity Sanitary Sewer and Non-Pressure Applications**

The following connections are to be used in conjunction with tie-ins to other non-pressure, gravity sewer piping and/or structures, and shall be as indicated in the construction documents.

* + 1. PVC Gasketed, Push-On Couplings
			- Acceptable couplings for joining fusible PVC pipe to other sections of fusible PVC pipe or other sections of PVC pipe shall include gasketed PVC, push-on type couplings as necessary.
			- PVC gasketed, push-on fittings and/or restraint hardware must be installed per the manufacturer’s guidelines.
		2. Sleeve-Type Couplings

 Sleeve-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as necessary.

* + 1. Expansion and Flexible Couplings

 Expansion-type mechanical couplings shall be manufactured for use with PVC pipe, and may be restrained or unrestrained as necessary.

* + 1. Connection Hardwire

 Bolts and nuts for buried service shall be made of non-corrosive, high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21.11, regardless of any other protective coating.

* + 1. Connection to Sanitary Sewer Manholes and Structures
			- Fusible PVC pipe shall be connected to manholes and other structures to provide a leak-free, properly graded flow into or out of the manhole or structure.
			- Connections to existing manholes and structures shall be as indicated in the construction documents.

- For a cored or drilled opening provide a flexible, watertight connection that meets and/or exceeds ASTM C923.

- For a knock out opening, provide a watertight connection (waterstop or other method) meeting the material requirements of ASTM C923 that is securely attached to the pipe with stainless steel bands or other means.

- Grout opening in manhole wall with non-shrink grout. Pour concrete collar around pipe and outside manhole opening. Provide flexible pipe joint or flexible connector within 2 feet of the collar.

* + - * Connections to a new manhole or structure shall be as indicated in the construction documents.
* A flexible, watertight gasket per ASTM C 923 shall be cast integrally with riser section(s) for all precast manhole and structures.
* Drop connections shall be required where shown on drawings.
* Grout internal joint space with non-shrink grout.
	1. **Maximum Allowable Pull-in Force**

Adhere to the following data regarding maximum allowable pull-in force for fusible PVC pipe used for trenchless application. The confirmation of proposed radius of each bore has to be part of the required submittal prior to construction.

|  |  |  |  |
| --- | --- | --- | --- |
| Pipe Diameter(in) | DimensionRatio(DR) | Max. Working Pressure(psi) | DIPS Series |
| PipeO.D.(in) | Min.Wall(in) | PipeI.D.(in) | Max. Pull-in Force (lbs.) |
| 4 | 14 | 305 | 4.80 | 0.34 | 4.07 | 13,400 |
| 6 | 14 | 305 | 6.90 | 0.49 | 5.85 | 27,700 |
| 8 | 14 | 305 | 9.05 | 0.65 | 7.68 | 47,700 |
| 10 | 14 | 305 | 11.10 | 0.79 | 9.42 | 71,800 |
| 12 | 14 | 305 | 13.20 | 0.94 | 11.20 | 101,600 |

**3.8 Minimum Bending Radius**

Adhere to the following data regarding radius of curvature for fusible PVC pipe used for trenchless application. The confirmation of proposed radius of each bore has to be part of the required submittal prior to construction.

|  |  |
| --- | --- |
| PipeDiameter(in) | DIPS Series |
| Critical Buckling Pressure(lbs.) | Minimum Allowable Bending(ft.) |
| 4 | 426 | 100 |
| 6 | 426 | 144 |
| 8 | 425 | 189 |
| 10 | 426 | 231 |
| 12 | 426 | 275 |

In any case, the deflection radius must not exceed 75% of the maximum allowable curvature allowed for standard C-900 PVC pipe.

# PART 4 EXECUTION

**4.1 Delivery and Off-Loading**

* + - All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the owner or engineer.
		- Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify owner or engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.
		- Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier’s guidelines shall be followed.
		- Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
		- During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
		- If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.
	1. **Handling and Storage**
		+ Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the owner or engineer.
		+ Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the owner or engineer.
		+ Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
		+ Pipe shall be handled and supported with the use of woven fiber pipe slings or

approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.

* + - If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
		- Pipe shall be stored and stacked per the pipe supplier’s guidelines.
	1. **Fusion Process**
		1. General
			1. Fusible PVC pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier’s guidelines.
			2. Fusible polyvinylchloride pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.

* + - 1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
			2. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:

Heat Plate - Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier’s guidelines.

Carriage – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.

General Machine - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

Data Logging Device – An approved data logging device with the current version of the pipe supplier’s recommended and compatible software shall be used. Data logging device operations and maintenance manual shall be with the unit at

all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

* + - 1. Other equipment specifically required for the fusion process shall include the following:

Pipe rollers shall be used for support of pipe to either side of the machine

A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier’s recommendations.

An infrared (IR) pyrometer for checking pipe and heat plate temperatures.

Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

Facing blades specifically designed for cutting fusible polyvinylchloride pipe shall be used.

* + 1. Joint Recording

 Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician’s joint report.

* 1. **General Installation**
		+ Installation guidelines from the pipe supplier shall be followed for all installations.
		+ The fusible PVC pipe will be installed in a manner so as not to exceed the recommended bending radius.
		+ Where fusible PVC pipe is installed by pulling in tension, the recommended Safe Pulling Force established by the pipe supplier shall not be exceeded.
	2. **Preparation Prior to Making Connections Into Existing Piping Systems**

 Approximate locations for existing piping systems are shown in the construction documents. Prior to making connections into existing piping systems, the contractor shall:

* Field verify location, size, piping material, and piping system of the existing pipe.
* Obtain all required fittings, which may include saddles, sleeve type couplings, flanges, tees, or others as shown in the construction documents.
* Have installed all temporary pumps and/or pipes in accordance with established connection plans.
* Unless otherwise approved, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.
	1. **Pipe System Connections**

 Pipe connections shall be installed per applicable standards and regulations, as well as per the connection manufacturer’s guidelines and as indicated in the construction documents. Pipe connections to structures shall be installed per applicable standards and regulations, as well as per the connection manufacturer’s guidelines.

* 1. **Tapping for Potable and Non-Potable Water Applications**
* Tapping shall be performed using standard tapping saddles designed for use on PVC piping in accordance with AWWA C605. Tapping shall be performed only with use of tap saddles or sleeves. NO DIRECT TAPPING WILL BE PERMITTED. Tapping shall be performed in accordance with the applicable sections for saddle tapping as per “Uni-Pub-8: Tapping Guide for PVC Pressure Pipe by Uni-Bell PVC Pipe Association”.
* All connections requiring a larger diameter than that recommended by the pipe supplier, shall be made with a pipe connection as specified and indicated on the drawings.
* Equipment used for tapping shall be made specifically for tapping PVC pipe:

- Tapping bits shall be slotted “shell” style cutters, specifically made for PVC pipe. ‘Hole saws’ made for cutting wood, steel, ductile iron, or other materials are strictly prohibited.

- Taps may be performed while the pipeline is filled with water and under pressure (‘wet’ tap,) or when the pipeline is not filled with water and not under pressure (‘dry’ tap).

* 1. **Testing**

 Testing shall comply with all applicable jurisdictional building codes, statutes, standards, regulations, and laws.

* + 1. Hydrostatic Testing and Leakage Testing for Pressure Piping

 All hydrostatic and leakage testing shall be in accordance to Sec 506.5 COD (Hydrostatic Test) as specified in City of Dallas Addendum to the North Central Texas Council of Governments (NCTCOG) Public Works Construction Standards, Latest Edition.

* + 1. Deflection Testing for Non-Pressure Piping
			- After completion of the backfill, the engineer or owner may require that a deflection test be performed.
			- Deflection tests should be conducted using a go/no-go mandrel. The mandrel’s outside dimension shall be sized to permit no more than 7.5 percent deflection. The percent deflection shall be established from the base inside diameter of the pipe. If the internal beading of the fused joints for the pipe is not required to be removed, the mandrel shall account for this clearance as well. The mandrel shall be approved by the owner or engineer prior to use. Lines that permit safe entry may allow other deflection test options, such as direct measurements.

**PART 5: METHOD OF MEASUREMENT AND PAYMENT**

Method of Measurement and Payment for the work included in this section will be in accordance with the payment schedule in the Bid Proposal.

**\*\*END OF SECTION\*\***