



SPECIFICATIONS

TEE-BASE PVC MANHOLE SYSTEM:
FIBERGLASS REINFORCED PLASTIC (FRP)
MANHOLE LINER (SADDLE CONFIGURATION)

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TEE-BASE PVC MANHOLE SYSTEM: FIBERGLASS REINFORCED PLASTIC (FRP) MANHOLE LINER (SADDLE CONFIGURATION)

I. SCOPE OF WORK

- A. This specification shall govern for the furnishing of all work necessary to accomplish and complete the installation of a Tee-Base PVC Manhole System, comprising fiberglass reinforced plastic lined concrete manhole base (saddle) and top sections, a polyvinyl chloride pipe riser section and all appurtenances. The Tee-base PVC Manhole shall be corrosion, abrasion, inflow and infiltration resistant.
- B. The Tee-Base PVC Manhole System shall be modular and shall include the following main components:
- 1) Fiberglass Reinforced Plastic (FRP) concrete protective liners comprising a manhole base (saddle) to be mechanically anchored to a straight large-diameter host sewer pipe resulting in a tee-base, and a manhole top section, including all appurtenances. Liners shall be **non-structural units, constructed of fiberglass reinforced unsaturated polyester resin, third-party certified for wastewater infrastructure use**, designed to provide a gastight and watertight homogenous barrier that protects the concrete manhole base and top sections from corrosion, abrasion, inflow and infiltration. FRP liners shall be manufactured by **Predl Systems North America Inc., Burnaby, BC**.
 - 2) Cast-in-place reinforced concrete base, cast around the manhole tee-base, supplied by others.
 - 3) Concrete manhole top section, cast around the FRP concrete protective top liner. Concrete base and top sections shall be ASTM C478 compliant and manufactured by **Diamond Precast Concrete Ltd., Burnaby, BC or a Predl Systems certified precast facility**.
 - 4) AWWA C900 compliant, DR-51 pressure class PVC pipe riser section, manufactured by **Diamond Plastics Corp., Grand Island, NE**.
 - 5) ASTM C990 compliant elastomeric sealant and ASTM C877 compliant external joint wrap, for the purpose of joining the manhole base (saddle) to the straight large-diameter host sewer pipe as well as the lined concrete tee-base, PVC pressure pipe riser and lined concrete top manhole sections. The sealant and external joint wrap shall be supplied by others.

II. GOVERNING STANDARDS

Manhole liners shall conform to the following design criteria:

- | | | |
|----|-------------|---|
| A. | ASTM D638: | Standard Test Method for Tensile Properties of Plastics |
| B. | ASTM D695: | Test Methods for Compressive Properties of Rigid Plastics |
| C. | ASTM D790: | Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and electrical Insulating Materials |
| D. | ASTM D792: | Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement |
| E. | ASTM D2240: | Standard Test Method for Rubber Property – Durometer Hardness |
| F. | ASTM D2584: | Test Method for Ignition Loss of Cured Reinforced Resins |
| G. | ASTM D4060: | Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber |

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- H. Greenbook 2009 Standard Specifications for Public Works Construction, Chemical Resistance Test
(or later): (Pickle Jar Test)

III. GENERAL DESCRIPTION

A. Configuration:

Each prefabricated FRP liner component shall be constructed from one piece homogenous composite and/or thermoplastic with minimum thickness of 3 mm (1/8"). FRP concrete protective liners shall be non-structural elements.

1. **FRP Base (saddle) Liners:** The Base (saddle) Liner shall have a spigot joint facing the PVC riser tube and connecting to the inside of the PVC pressure pipe riser, and a smooth FRP flange, facing downward, conforming to the outside curvature of the straight large-diameter host sewer pipe for the purpose of establishing the tee-base. An ASTM C990 compliant butyl rubber sealant, such as ConSeal CS-102, shall be used in all interfaces. An ASTM C877 compliant external joint wrap, such as ConSeal CS-212, shall be used to seal the joint between the tee-base and the PVC riser tube from the outside.

All metallic mechanical devices and bolt assemblies used to mechanically attach the FRP Base (saddle) to the straight large-diameter host sewer pipe shall be constructed of corrosion resistant materials meeting the physical properties and chemical composition requirements of ASTM A493 and A666, Type 302 through Type 316.

The FRP Base (Saddle) shall include an inner bench surface.

2. **FRP Top Liner with integral Access Collar and Gasket:** The FRP Top Liner component shall provide concrete protection from corrosion, abrasion, inflow and infiltration for the manhole top section and shall feature an integral FRP Access Collar and Gasket at the manway opening, to receive an FRP Telescoping Access Tube.

The FRP Top Liner shall either have cone or flat top configuration depending on the requirements of Contract Documents.

The Top Liner shall have a spigot joint facing the PVC riser tube and connecting to the inside of the PVC pressure pipe riser. An ASTM C990 compliant butyl rubber sealant, such as ConSeal CS-102, shall be used in the joint interface. An ASTM C877 compliant external joint wrap, such as ConSeal CS-212, shall be used to seal the joint from the outside.

3. **Telescoping Access Tube:** The FRP Telescoping Access Tube shall provide concrete protection from corrosion, abrasion, inflow and infiltration for the manway entry section, between the casting at the finished grade and top of the manhole top section. The Telescoping Access Tube shall accommodate grading adjustments up to 12" of height. Larger grading adjustments, as agreed upon between purchaser and the manufacturer, are covered by this specification

B. Dimensions:

1. FRP Base and Top Liners shall have spigot joint diameters of 48.80", 55.30" and 59.19", corresponding to the inside diameters of 48", 54" and 60" C900 DR-51 PVC pressure pipes. Tolerance on the spigot joint diameter shall be +0/-0.125". Other diameters, as agreed upon between purchaser and the manufacturer, are covered by this specification.
2. Access Collars and Telescopic Access Tube shall accommodate manway openings of 24", 27", 32" or 36". Telescopic Access Tube shall have a nominal height of 15". Access Collars can be either eccentric or concentric.

C. Marking and Identification

All components shall be marked with the following information:

- 1) Manufacturer's identification
- 2) Nominal diameter
- 3) Manhole identification
- 4) Installation assist marks, if applicable

IV. MATERIALS

- A. **FRP liner body:** The resins used shall be unsaturated, supplier certified, commercial grade polyester resins. Mixing lots of resin from different manufacturers, or "odd-lotting" of resins shall not be permitted. Quality-assurance records on the resin shall be maintained.

The reinforcing materials shall be commercial grade "E-CR" type glass, specially formulated for corrosive environments, in the form of mat, chopped roving, continuous roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and resin. Fiberglass and/or polypropylene ribs and/or structural members may be utilized to meet the design criteria.

No inert fillers shall be used. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard.

The laminate shall consist of multiple layers of glass matting and resin. The surface exposed to the sewer/chemical environment shall be resin rich and shall have no exposed fibers.

- B. **Mechanical devices:** All metallic mechanical devices and bolt assemblies shall be constructed of corrosion resistant materials meeting the physical properties and chemical composition requirements of ASTM A493 and A666, Type 302 through Type 316.
- C. **Third party accessories:** Third party accessories integral to the PVC Manhole System or the FRP Manhole Liner (flow control devices, valves, gates, inside drop assembly, man entry ladder, etc.) shall be governed by the respective manufacturers' materials specifications.

V. MANUFACTURE

- A. Manufacturer shall have 25 years of FRP concrete protective liner manufacturing experience and shall have fabricated and delivered at least 20,000 FRP concrete protective liners for wastewater applications.

VI. REQUIREMENTS

- A. **Exterior Surface:** The exterior surface shall be finished with embedded aggregates and FRP bonding bridges to allow for adequate bonding with the surrounding concrete once cast. The exterior surface shall be free of blisters larger than 0.5" in diameter, delamination and fiber show, except in the vicinity of FRP bonding bridges where fiber show is acceptable. **Gel-coat or paint or other coatings are not allowed.**
- B. **Interior Surface:** The interior surfaces shall be resin rich with no exposed fibers. Interior flow surfaces shall be smooth for improved corrosion resistance and reduced sludge build-up. The surface shall be free of crazing, delamination, blisters larger than 0.25" in diameter, and wrinkles of 0.125" or greater in depth. **Gel-coat shall be permitted on interior surfaces, no paint or other coatings are allowed.**
- C. **Repairs:** Any manhole liner repair is required to meet all requirements of this specification. All repair must all be preapproved by the manufacturer.
- D. **Chemical Resistance:** FRP manhole liners must demonstrate having sufficient corrosion resistance by

passing the “Greenbook” 2009 edition (or later), Standard Specifications for Public Works Construction, Chemical Resistance Test (Pickle Jar Test), per third-party accredited laboratory test results.

E. Physical Properties:

All FRP liner material shall have the following physical properties when tested at 77 °F ± 5 degrees:

Property	Standard	Units	Initial	(Par. VI.F.)
Density	ASTM D792	g/cm ³	1.02	
Thickness	--	Mm	3 min.	--
Tensile Strength	ASTM D638	psi	7,000 min.	6,500 min.
Hardness (Shore “A”)	ASTM D2240		95-97	89-97
Weight change	--	--	--	0.05% max.
Flexural Strength	ASTM D790	lbf	124 avg.	--
Compressive Strength	ASTM D695	psi	13,000	--
Ignition Loss	ASTM D2584	%	52 avg.	--
Taber abrasion test (weight loss)	ASTM D4060	%	0.075	--

Tensile specimens shall be prepared and tested in accordance with ASTM D412 using Die B. Weight change specimens shall be 1 IN by 3 IN samples.

Upon request, the manufacturer shall provide written certification that the FRP liners used meets or exceeds the requirement of this specification.

F. Chemical resistance

After conditioning to constant weight at 110 °F, FRP liner specimens shall be exposed to the following solutions for a period of 112 days at 77 °F ± 5 degrees, as prescribed in Standard Specifications for Public Works Construction, section 211-2 (Pickle Jar Test).

At 28-day intervals, tensile specimens and weight change specimens shall be removed from each of the chemical solutions and tested. If any specimen fails to meet the 112-day requirement before completion of the 112-day exposure, the material will be subject to rejection.

Chemical Solution	Concentration
Sulfuric acid	20%*
Sodium hydroxide	5%
Ammonium hydroxide	5%*
Nitric acid	1%*
Ferric chloride	1%
Sodium hypochlorite	1%
Soap	0.1%
Detergent (linear alkyl benzyl sulfonate or LAS)	0.1%
Bacteriological	BOD not less than 700 ppm

* Volumetric percentages of concentrated C.P. grade reagents.

VII. TEST METHODS

All test methods shall be performed per corresponding ASTM standard and per “Greenbook” 2009 edition (or later), Standard Specifications for Public Works Construction, Chemical Resistance Test (Pickle Jar Test).

VIII. QUALITY ASSURANCE/QUALITY CONTROL

- A. **Examination:** Each manhole liner shall be examined for dimensional requirements and workmanship.
- B. **Composition Control:** Controls on glass and resin content shall be maintained for all manufacturing processes and for each portion of manhole liner fabrication. Records shall be maintained for these control checks. Proper glass content may be shown by glass usage checks or glass and resin application rate checks.
- C. **Certified facility:** The manhole liners shall be designed and manufactured in an ISO 9001 and 14001 certified manufacturing facility.

IX. HANDLING AND STORAGE

- A. FRP manhole liners must not be dropped or impacted. When stored for extended periods (more than a few days). Liners shall be stored on a flat surface to minimize deformation.

Liners shall not be exposed to direct sunlight for extended periods.

X. CASTING & INSTALLATION

- A. **Casting:** FRP manhole liners are non-structural components. Liners must be monolithically cast within a concrete manhole section using a wet cast method. Custom pouring supports shall be provided with FRP liners to fully support the liners during the concrete pouring process against the vertical and horizontal forces created by the concrete during casting.

The poured manhole base and top sections must not be disturbed until adequate hydration has occurred.

Lifting devices must not penetrate any surface of the liner. No liner may have holes or openings which will permit the intrusion of liquids or gases through the liner wall and into the concrete.

- B. **Installation:** The Tee-Base PVC manhole installation should strictly follow the Predl Systems' recommended installation procedures to ensure long-term corrosion resistant service.