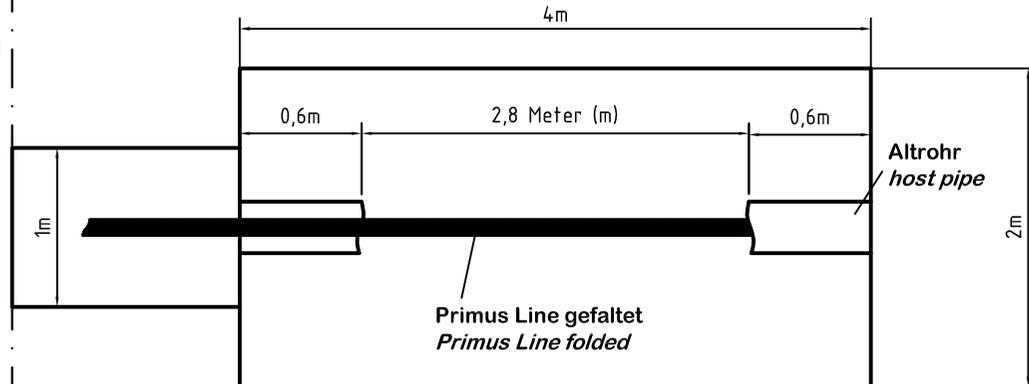
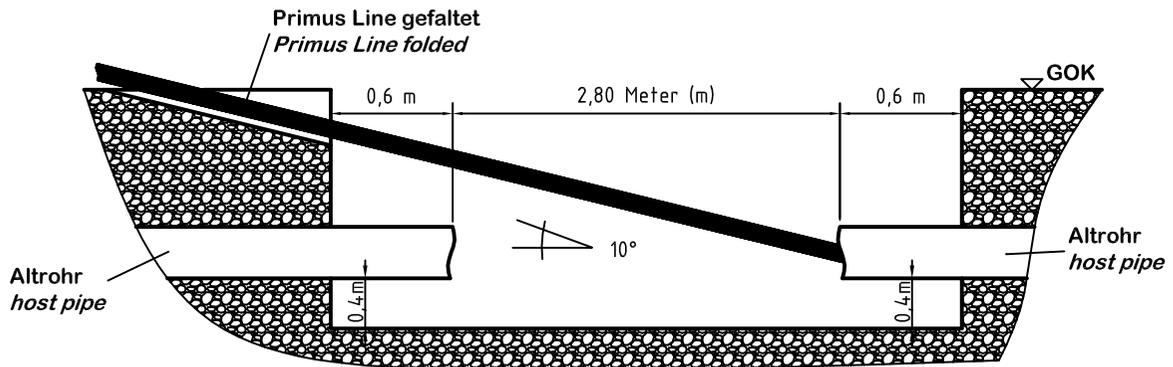


Grundriss Baugrube
horizontal view excavation pit



Längsschnitt Baugrube
longitudinal section excavation pit



Rädlinger primus line GmbH Kammerdorfer Straße 16, D-93413 Cham Telefon / Phone +49 9971 - 4003 - 100 / Fax +49 9971 - 4003 - 123 primusline@raedlinger.com / www.primusline.com			Systemzeichnung / System drawing		
Dateiformat X-CAD-2004	Datum	Name	Maßstab Scale 1 : 15		
Erst	02.08.2012	T. Häring	Baugrubenmaße <i>Excavation dimensions</i>		
Gepr					
Speicher-/Ausgabe-Datum/Zeit 2012-06-15 13:03	zuletzt bearbeitet von THOMAS HAERING				
			Zeichnungsnummer / Drawing CAD No. GB-02 / Wasser		Blatt / sheet 001



Designation: F3708 – 25

Standard Specification for Aramid Fiber Reinforced Flexible Fabric-Reinforced Pipe (FFRP) for Loose-fit Non-Interactive Pressure Pipeline Rehabilitation¹

This standard is issued under the fixed designation F3708; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers materials, and test requirements for flexible fabric reinforced pipe (FFRP) made with fabric reinforcement consisting of para-aramid fibers or a combination of para-aramid and polyester fibers.

1.2 FFRP produced to this specification is for use in pressure pipeline rehabilitation by installing a continuous factory modified “U” or “C” shaped flexible aramid fiber-reinforced pipe into an existing pipeline, then reverting it to its original round shape using air or water pressure to achieve a loose-fit condition within the bore of the existing pipeline as a non-interactive pipe within a pipe.

1.3 FFRP produced to this specification are intended for the rehabilitation of a variety of pressure pipelines that transport potable and non-potable water, raw water, fire water, municipal sewage, sea water, brine, and industrial process liquids.

1.4 The same pipe may be used as an above ground or stand-alone piping system for water or other fluid transport, such as emergency water pipelines, temporary bypass pipelines, and similar point-to-point pressurized applications.

NOTE 1—This specification does not purport to address comprehensive guidance on the selection of a product, project design considerations, joining systems, installation and special products and piping systems for specialized pressure applications. Users are advised to consult the manufacturer for application-specific testing requirements.

1.5 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trendless Plastic Pipeline Technology.

Current edition approved July 1, 2025. Published July 2025. DOI: 10.1520/F3708-25

1.7 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D882 Test Method for Tensile Properties of Thin Plastic Sheeting
- D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
- D1907 Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2240 Test Method for Rubber Property—Durometer Hardness
- D2992 Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- D7269 Test Methods for Tensile Testing of Aramid Yarns
- F412 Terminology Relating to Plastic Piping Systems
- F3314 Terminology Relating to Technology and Underground Infrastructure

2.2 American Petroleum Institute (API) Standards:³

- SPEC 15S ,3rd Edition, April 2022 - Spoolable Reinforced Plastic Line Pipe

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

³ Available from American Petroleum Institute (API), 200 Massachusetts Ave. NW, Suite 1100, Washington, DC 20001, <http://www.api.org>.

2.3 EN Standards⁴

14632 Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Guidance for the assessment of conformity

2.4 DIN Standards:⁵

DIN 53504 Testing of rubber - Determination of tensile strength at break, tensile stress at yield, elongation at break and stress values in a tensile test

DIN CEN/TS 14632 Plastics piping systems for drainage, sewerage and water supply, pressure and non-pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP) - Guidance for the assessment of conformity

2.5 ISO Standards:⁶

48 Rubber vulcanized or thermoplastic - Determination of hardness.

527 Plastics - Determination of tensile properties

868 Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)

1133 Plastics - Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics.

1183 Plastics - Methods for determining the density of non-cellular plastics.

1402 Rubber and Plastic Hoses and Hose Assemblies – Hydrostatic Testing

1833-1 Textiles- Quantitative Chemical Analysis Part 1: General Principles of Testing

18833-25 Textiles- Quantitative Chemical Analysis Part 25: Mixtures of Polyester with Certain Other Fibers (Method Using Trichloroacetic Acid and Chloroform)

2062 Textiles - Yarns from packages - Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester.

3126 Plastics piping systems - Plastics components - Determination of dimensions

9001 Quality management systems – Requirements

23856 Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage - Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin

2.6 NSF/ANSI/CAN Standards:⁷

61 Drinking Water System Components - Health Effects

3. Terminology

3.1 General—unless otherwise specified, definitions and terminology are in accordance with Terminologies F412 and F3314.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 fabric, n—a seamless, continuous woven textile containing aramid reinforcements in one or more layers which provides strength and flexibility.

3.2.2 flexible fabric-reinforced pipe (FFRP), n—a thermoplastic continuous, seamless pipe reinforced with Kevlar⁸ woven fibers, or a combination of Kevlar woven fibers and polyester fibers, manufactured through a continuous and simultaneous process of fiber weaving and thermoplastic extrusion as defined in F3314 (see Fig. 1).

3.2.2.1 Discussion—FFRP is designed to be loose fit within the host pipe and withstand the internal pressures within the host pipe (see Fig. 2b).

3.2.3 inner layer, n—a thermoplastic polyethylene (PE) or thermoplastic polyurethane (TPU) membrane extruded onto the inner surface of the fabric as a protective coating and fluid barrier.

3.2.4 loose-fit, n—a pipe which lays freely within the host pipe and does not interact with the existing host pipe (see Fig. 2b).

3.2.5 modified pipe—a flexible fabric-reinforced thermoplastic pipe extruded round that has been folded to achieve a reduced cross-sectional, most commonly a “U” or Shape, that enables it to be inserted into a pipeline that needs rehabilitation (see Fig. 2a).

⁴ Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsigroup.com>.

⁵ Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, <http://www.din.de>.

⁶ Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

⁷ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, <http://www.nsf.org>.

⁸ Kevlar® is trademarked by DuPont de Nemours, Inc.

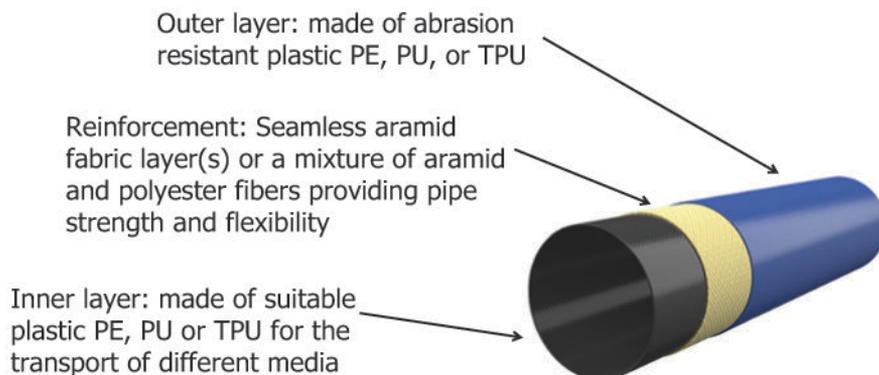
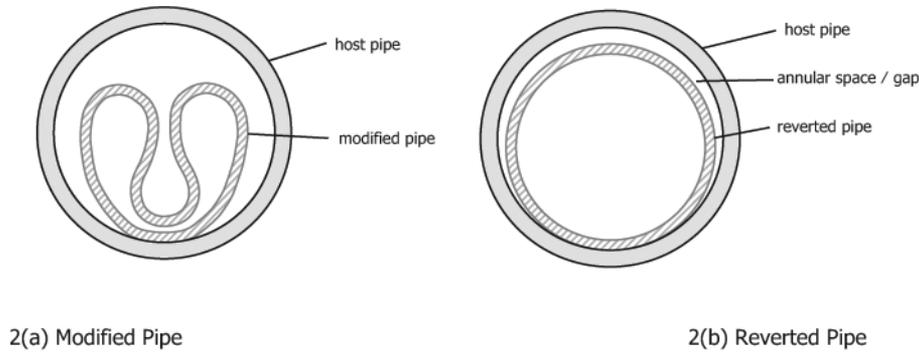


FIG. 1 Schematic Drawing of FFRP Covered by This Specification.



NOTE 1—This figure is intended only for clarification of terms specific to this specification and shows representative modified and reverted pipe shapes. Other modified pipe shapes may meet the general requirements of this specification.

FIG. 2 Modified Pipe and Reverted Pipe—Terminology

3.2.6 *outer layer, n*—a thermoplastic polyethylene (PE) or thermoplastic polyurethane (TPU) membrane extruded onto the outer surface of the fabric as a protective coating and fluid barrier.

3.2.7 *para-aramid (aramid), n*—member of the class of PPTA (p-phenylene terephthalamide) fiber-forming synthetic aromatic polyamides in which at least 85 % of the amide linkages are attached directly to two aromatic rings.

3.2.8 *polyester fiber, n*—a member of the class of PET (polyethylene terephthalate) fiber-forming thermoplastic resin in the polyester family of polymers.

3.2.9 *reinforcement, n*—the seamless aramid fabric layer or layers of aramid, or a combination of aramid and polyester fiber made to strengthen the pipe and accommodate the internal pressure loads and absorption of tractive forces during installation.

3.2.10 *reverted pipe*—a modified flexible fabric-reinforced thermoplastic pipe after returning to its original round shape by forced air pressure or water (see Fig. 2b).

4. Materials and Manufacture

4.1 *Polyethylene material requirements*—PE suitable for use in the manufacturing of flexible fabric-reinforced pipe under this specification shall meet Table 1 requirements.

4.2 *Rework Material*—Only PE material in a form such as granules that has not been subjected to use or processing other than that required for its manufacture and to which no reworked or recycled materials have been added shall be used in extrusion manufacturing of products under this specification.

4.3 *Color*—If the piping is intended for water service, the outer layer’s color shall be blue or blue stripes for identification for pipe service. The choice of color shall follow national identification requirements.

4.4 *Thermoplastic Polyurethane material requirements*—TPU suitable for use in the manufacturing of flexible fabric reinforced pipe under this specification shall meet Table 2 requirements.

4.5 *Rework Material*—Only TPU material in a form such as granules that has not been subjected to use or processing other than that required for its manufacture and to which no rework or recyclable materials have been added shall be used in extrusion manufacturing of products under this specification.

4.6 *Aramid material requirements*—Aramid suitable for use in the manufacturing of flexible fabric reinforced pipe under this specification shall be continuous yarns and meet Table 3 requirements.

4.7 *Rework Material*—Only Aramid yarn that has not been subjected to use or processing other than that required for its manufacture and to which no rework or recyclable materials have been added shall be used in extrusion manufacturing of products under this standard.

4.8 *Polyester material requirements*—Polyester suitable for use in the manufacturing of flexible fabric reinforced pipe under this specification shall be continuous yarns and meet Table 4 requirements.

4.9 *Rework Material*—Only polyester yarn that has not been subjected to use or processing other than that required for its manufacture and to which no rework or recyclable materials

TABLE 1 Minimum PE Material Requirements

Material Property	Material Standard	Value
Density	Test Method D792 or ISO 1183	≤0.935 g/cm ³
Initial Tensile Strength	Test Method D882 or ISO 527	≥1450 psi (≥10 MPa)
Elongation at Break	Test Method D882 or ISO 527	≥400 %
Shore hardness (D)	Test Method D2240 or ISO 868 or ISO 48	≤60

TABLE 2 Minimum TPU Material Requirements

Material Property	Material Standard	Value
Density	Test Method D792 or ISO 1183	≤1.25 g/m ³
Initial Tensile Strength	Test Method D882 or ISO 527	≥5800 psi (≥40 MPa)
Elongation at Break	Test Method D882 or ISO 527	≥350 %
Shore hardness (D)	Test Method D2240 or ISO 868 or ISO 48	≤98

TABLE 3 Minimum Material Requirements For Aramid Yarn

Properties	Test Method	Units	Limit
Linear Density	ASTM D1907	dtex (den)	> 8.000 (7.200)
Tensile Strength at Break	ASTM D7269 or ISO 2062	lb. (Newton)	1500 (> 337)
Elongation at Break	ASTM D7269 or ISO 2062	%	> 2.5

TABLE 4 Minimum Material Requirements For Polyester Yarn

Properties	Test Method	Units	Limit
Linear Density	ASTM D1907	dtex (den)	> 8.000 (7.200)
Tensile Strength at Break	ASTM D7269 or ISO 2062	lb. (Newton)	500 (>112)
Elongation at Break	ASTM D7269 or ISO 2062	%	< 30

have been added shall be used in extrusion manufacturing of products under this standard.

5. Requirements

5.1 Facility—Products compliant with this standard shall be manufactured in a facility with ISO 9001 or adequate certification.

5.2 Workmanship—The pipe surfaces shall be homogeneous and uniform in color, opacity, and density. The surfaces shall be free of cracks, holes, blisters, voids, and foreign inclusions or other defects visible to the naked eye. Variations of surface caused by production processes are allowed under the condition that those variations are documented and verified to cause no change in properties specified in this standard by the manufacturer.

5.3 The FFRP shall be a thermoplastic pipe reinforced with aramid fiber or reinforcements containing aramid and polyester fiber woven yarns. For fabric reinforcement made of a combination of para-aramid and polyester fibers a minimum of 25 wt.% aramid fibers must be used and verified by ISO 1833-1 and ISO 1833-25 by a third-party accredited testing laboratory.

5.4 The FFRP composite shall be comprised of three or more layers and manufactured by a simultaneous process of fiber weaving and thermoplastic extrusion.

5.5 The reinforcement of the FFRP shall consist of one or more layers of aramid or a combination of aramid and polyester and meet the requirements of **4.1 – 4.5**, respectively. The construction shall form a continuous and seamless woven fabric of one or more individual layers. It is not required that the multiple layers of fabric be joined in any way.

5.6 The outer and inner layers shall be PE or TPU meeting the requirements of **4.1 – 4.5**, respectively regarding the media transported.

5.7 Continuous automated, 100 % machine monitoring using optical sensors or equivalent shall be utilized to ensure the FFRP’s inner and reinforcement layers are free from defects.

5.8 FFRP shall be manufactured in continuous lengths, then modified and spooled onto reels for transportation in accordance with API 15S:2022 5.3.8.3 - Effects of Handling and Spooling.

5.9 Measurements of adhesion—for inner and outer layers shall be made at the beginning and end of each production run. The adhesion of inner and outer layers shall exceed a force of 45.0 N per 1 in. (25 mm).

5.10 Pressure Rating Classification—shall be based on the reinforcement composition. Each Class and diameter will have different pressure capabilities and shall be determined by long-term testing and short-term burst testing in accordance with Practice **D2992**, Test Method **D1598** and Test Method **D1599**.

5.11 Test Frequency for Short-term Burst Pressure—Short-term burst pressure shall be measured for each production run. A production run shall consist of all FFRP of the same size, reinforcement and inner and outer layer composition produced on a single manufacturing line and shall be tested at the beginning of production. The burst pressure shall meet or exceed the minimum acceptable short term burst pressure stated in the manufacturer’s product data sheet for that run.

NOTE 2—The requirements for **5.10** and **5.11** are for manufacture quality control and proof-testing only and should not be interpreted as applicable to in situ testing for acceptance of installed systems. See appropriate installation and leak testing standards or manufacturer’s recommendations for field testing procedure.

5.12 Potable Water Requirement Health Effects Requirements—When required by the regulatory authority having jurisdiction, products intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF/ANSI/CAN Standard No. 61 by an acceptable certifying organization.

5.13 Dimensions and Tolerances:

5.13.1 Inner/Outer Layer and Total Wall Thickness—Thickness of inner and outer PE or TPU layer as well as the total wall thickness shall be equal to or greater than their respective minimum value set in **Table 5** for the nominal diameter of the pipe sample when measured in accordance with **6.1**.

5.13.2 Reinforcement Layer—The reinforcement shall form a continuous and seamless fabric.

TABLE 5 Dimensions of FFRP

Nominal Diameter	Minimum Wall Thickness	Minimum Thickness of Internal Layer	Minimum Thickness of Outer Layer
in. (mm)	in. (mm)	in. (mm)	in. (mm)
2 (50)	0.12 (3.0)	0.03 (0.8)	0.02 (0.6)
2.5 (65)	0.12 (3.0)	0.03 (0.8)	0.02 (0.6)
3 (80)	0.13 (3.2)	0.03 (0.8)	0.02 (0.6)
4 (100)	0.14 (3.6)	0.04 (1.0)	0.03 (0.7)
5 (125)	0.16 (4.0)	0.04 (1.0)	0.03 (0.7)
6 (150)	0.16 (4.0)	0.04 (1.0)	0.03 (0.7)
8 (200)	0.18 (4.5)	0.04 (1.0)	0.03 (0.8)
10 (250)	0.18 (4.5)	0.04 (1.0)	0.03 (0.8)
12 (300)	0.18 (4.5)	0.04 (1.0)	0.03 (0.8)
14 (350)	0.20 (5.0)	0.04 (1.0)	0.04 (0.9)
16 (400)	0.20 (5.0)	0.04 (1.0)	0.04 (0.9)
18 (450)	0.20 (5.0)	0.04 (1.1)	0.04 (1.0)
20 (500)	0.20 (5.0)	0.04 (1.1)	0.04 (1.0)
24 (600)	0.20 (5.0)	0.05 (1.2)	0.04 (1.1)
28 (700)	0.24 (6.0)	0.05 (1.2)	0.04 (1.1)
32 (800)	0.24 (6.0)	0.05 (1.2)	0.04 (1.1)

5.13.3 *Outside Diameter Dimensions and Tolerances*—The average outside diameter of the round pipe sample shall be given in data sheets with a tolerance of 0.079 in. (± 2 mm) when measured in accordance with 6.3.

5.13.3.1 The outside diameter of the FFRP shall be designed and manufactured for a loose-fit and independent from the host pipe application within the host pipe with a continuous annular space under all operating conditions throughout its lifetime. The manufacturer shall specify the outside diameter and annular gap in accordance with this specification.

5.13.4 *Visual Inspection and Dimension Verification*—The pipe length shall be visually inspected for workmanship defects at the manufacturer's plant. Measurements of outside diameter and wall thickness shall be made at the beginning and end of each production run.

6. Test Methods

6.1 *Measurement of Wall Thickness for Individual Layers*—The wall thickness of individual layers shall be performed according to the procedure described in Annex A1 with the following stipulations: The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity. A representative sample shall be taken during continuous production.

6.2 *Measurement of Total Wall Thickness*—The wall thickness shall be measured in accordance with Test Method D2122 or ISO 3126 with the following stipulations: The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity. A representative sample shall be taken during continuous production.

NOTE 3—Care should be taken to avoid excessive closure pressure when using micrometers and calipers, which may compress the specimen and give falsely low readings. Care should be taken to avoid misalignment with the longitudinal axis of the specimen when using micrometers, which may bridge specimen surface curvature or indentations and give falsely high readings.

6.3 *Measurement of Outside Diameter*—The pipe outside diameter shall be measured in accordance with Test Method D2122 or ISO 3126 with the following stipulations:

6.3.1 The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity. A representative sample shall be taken during continuous production. The sample must be pressurized to a level which reflects conditions in use. Pressure levels are dependent on the manufacturer's products maximum allowable operating pressure (MAOP) and shall range from a minimum of 29 psi (2 bar) up to 435 psi (30 bar) and shall in no case exceed MAOP. Only specifically designed connector fittings given by the manufacturer shall be used for testing. The respective test pressure level shall be stated in the test report.

NOTE 4—It is acceptable to conduct the measurement of outside diameter as part of the short-term burst pressure (STBP) test as discussed in 6.3.

6.4 *Tensile strength of the FFRP*—Measurement of the tensile strength of the FFRP shall be made on appropriate testing machinery for tensile testing. Samples shall be fixed on the testing machinery with standard insertion tools for on-site installation of the FFRP as given by the manufacturer. The

measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity. A representative sample shall be taken during continuous production. Free sample length shall be according to ISO 23856, 5.3.6.5.1 Dimensions of test pieces – For method A. Test speed shall be 10 in/min (250 mm/min).

6.5 *Long-term hydrostatic strength*—of FFRP compliant with this standard shall be tested in accordance with Practice D2992 and Test Method D1598 with the following stipulations:

6.5.1 The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity if tested in air as external medium. A representative sample shall be taken during continuous production. Free sample length shall be according to ISO 23856, 5.3.6.5.1 Dimensions of test pieces – For method A. Only specifically designed connector fittings given by the manufacturer shall be used for testing. Connector fittings shall not be restrained during testing. The measurements shall be made on a representative commercially available nominal diameter. Conformity to the representative diameter according to DIN CEN/TS 14632 Annex D.2.1 may be used to verify other nominal diameters.

6.6 *Short Term Burst Pressure (STBP)*—The burst pressure for each nominal pipe diameter shall be qualified in accordance with Test Method D1599 procedure A or ISO 1402 with the following stipulations: Allowed time to burst shall be between seven (7) and ten (10) minutes. The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity if tested in air as external medium. A representative sample shall be taken during continuous production. Free sample length shall be according to ISO 23856 5.3.6.5.1 Dimensions of test pieces – for method A. no conditioning of the sample is required. Only specifically designed connector fittings given by the manufacturer shall be used for testing. Connector fittings shall not be restrained during testing. The individual burst pressures of no less than 3 replicates shall be averaged to obtain the average short term burst pressure.

NOTE 5—The permissible bursting time of seven (7) to ten (10) minutes has been determined due to the inverted expansion behavior of FFRP compared to standard HDPE pipes during a standard burst test. For FFRP high expansion takes place at the start, which subsequently decreases to the point shortly before bursting, where almost no more expansion can be observed. Depending on the size of the sample the requirement of shorter bursting times can therefore lead to either unstable bursting behavior and invalid results for smaller samples or complete unfeasibility for larger samples.

6.7 *Inner and Outer Layers Adhesion Testing*—Measurement of layer adhesion of inner and outer layer shall be performed according to the procedure described in Annex A2 with the following stipulations: The measurements shall be made at $73\text{ }^{\circ}\text{F} \pm 18\text{ }^{\circ}\text{F}$ ($23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$) and ambient humidity. A representative sample shall be taken during continuous production.

6.8 *Re-test and Rejection*—Unless specified otherwise in this specification, if the results of any test(s) do not meet the requirements of the specification, retesting products represented by the test(s) by agreement between the manufacturer and the purchaser is permissible. However, there shall be no agreement to alter minimum requirements such as by omitting

tests that are part of this specification, substituting or modifying a test method, or changing specification limits. In retesting, the requirements of the specification shall be met, and the test methods designated in this specification shall be followed. If failure occurs upon retest, the product quantity represented by the test(s) does not meet this specification's requirements.

7. Workmanship, Finish, and Appearance

7.1 The FFRP shall be uniform in color, opacity, density and continuous throughout its entire length. The FFRP shall have at least three distinct layers. The inside and outside surfaces of the FFRP shall be semi-matte or glossy in appearance. The FFRP surfaces shall be free of cracks, holes, blisters, voids, and foreign inclusions.

8. Product Marking

8.1 *Quality of Marking*—The marking shall be applied to the outer surface of the pipe so that it remains legible and visible. The markings shall be spaced at intervals of 5 feet (1.5 m) or less. Marking in a color that contrasts with that of the outer surface of the pipe is preferred.

8.2 *Pipe Markings*—As a minimum each length of pipe shall be clearly marked by the manufacturer with the following information:

- (1) The manufacturer's product trade name, or trademark;
- (2) This designation "ASTM F3708" and/or other technical specifications;
- (3) The nominal pipe outside diameter;
- (4) Maximum Allowable Operating Pressure (MAOP) in bar / psi as determined by this specification;
- (5) The manufacturer's serial number, lot number, and designation are traceable to the manufacturing facility;
- (6) The day, month, and year of manufacture in the format DDMMYYYY;
- (7) The continuous production run length in feet or meters, internal product code and manufacturing machine designation (as marked in the inspection certificate and certificate of origin); and

(8) Products successfully evaluated, tested, and certified for conformance with NSF/ANSI/CAN Standard No. 61 or other standards for the transport of potable water by an acceptable certifying organization shall also include the seal or mark of the laboratory making the evaluation for this purpose, spaced at intervals specified by the laboratory.

9. Quality Assurance

9.1 When the product is marked with this designation, ASTM F3708, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

10. Test Reports and Certification

10.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser that the pipe was manufactured, sampled, tested, and inspected in accordance with this specification. Each certification shall be signed by an authorized agent of the manufacturer.

11. Packaging

11.1 All FFRP, unless otherwise specified, shall be spooled onto reels in accordance with the manufacturer's specification for commercial transport in accordance with API 15S:2022 5.3.8.3.

12. Handling and Storage

12.1 All FFRP shall be handled and stored in accordance with the manufacturer's written recommendations and procedures.

13. Keywords

13.1 aramid fiber; FFRP; flexible fabric reinforced pipe; pipe rehabilitation; trenchless rehabilitation

ANNEXES

(Mandatory Information)

A1. TEST METHOD FOR DETERMINATION OF WALL THICKNESS FOR INDIVIDUAL LAYERS OF FFRP

A1.1 *Scope*—This test method describes the necessary equipment and the procedure to measure individual wall thickness for thermoplastic layers of FFRP.

A1.2 *Equipment*—A caliper with a minimum reading accuracy of 0.0005 inches (0.013 mm) shall be used for measurement.

A1.3 *Procedure*—A sample with a minimum length of 20 in. (500 mm) is cut from the FFRP and the cut surface is measured at 8 measuring points as shown in Fig. A1.1. At

every measurement point the measurement shall be taken at the peaks of the reinforcement (= lowest thickness for extruded layer) as shown in Fig. A1.2. All single measurements shall be recorded, and the mean value of those measurements shall be formed as the resulting value of the measurement.

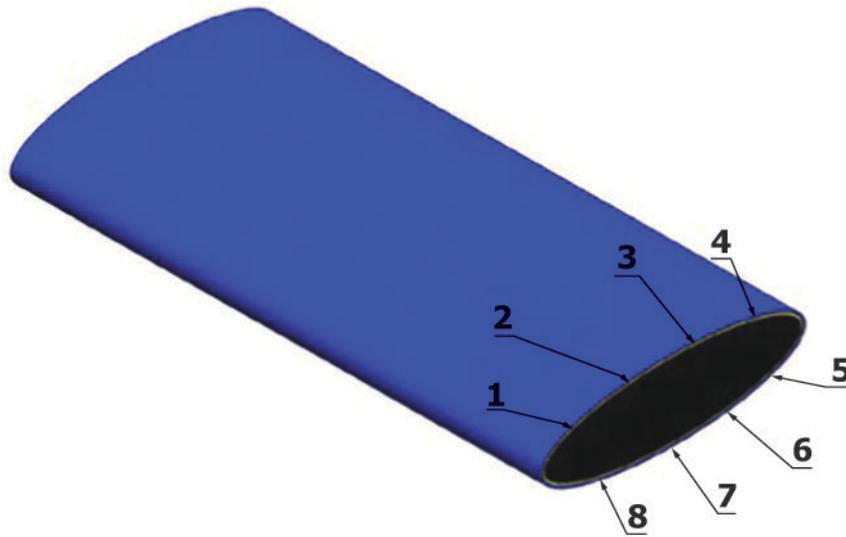


FIG. A1.1 Measuring Points for Measurement of Wall Thickness for Individual Layers of FFRP.



FIG. A1.2 Exemplary View on a Cut Surface and Where to Measure Layer Thickness for Thermoplastic Layers.

A2. TEST METHOD FOR DETERMINATION OF INNER AND OUTER LAYER ADHESION OF FFRP

A2.1 *Scope*—This test method describes the necessary equipment and the procedure to measure adhesion for thermoplastic layers to the reinforcement layer of FFRP.

A2.2 *Equipment*—For preparation of the sample a stencil plate (see Fig. A2.1), a cutter, a cordless drill, a drill bit with 5/16 in. (8 mm) diameter, pliers, screw clamps and a cloth are needed. For the actual measurement a force gauge (covering the appropriate measuring range) with a hook attached to it (see Fig. A2.2) is used.

A2.3 *Procedure*—A sample with a minimum length of 20 in. (500 mm) is cut from the FFRP. The cut section is then cut into half tubes. Both halves of the tubes are cleaned with a

cloth, including removal of dust particles. The first half tube is positioned on a table, so the inner layer is facing upwards and fixated/flattened in this position with screw clamps. The stencil plate is then placed onto the flattened half tube and fixated with screw clamps. Then the inner layer is cut carefully according to the stencil plate. The reinforcement layer must be unharmed by the cutting. Lift the beginning of the strip by using pliers to the point of uniform strip width. Drill a hole into the inner layer in the beginning of the strip to create an insertion hole for the hook of the force gauge. Take off screw clamps and stencil plate from the sample. Position the sample on the floor and hook the force gauge onto the sample. Set force display of the force gauge to 0. The person performing the test steps onto the

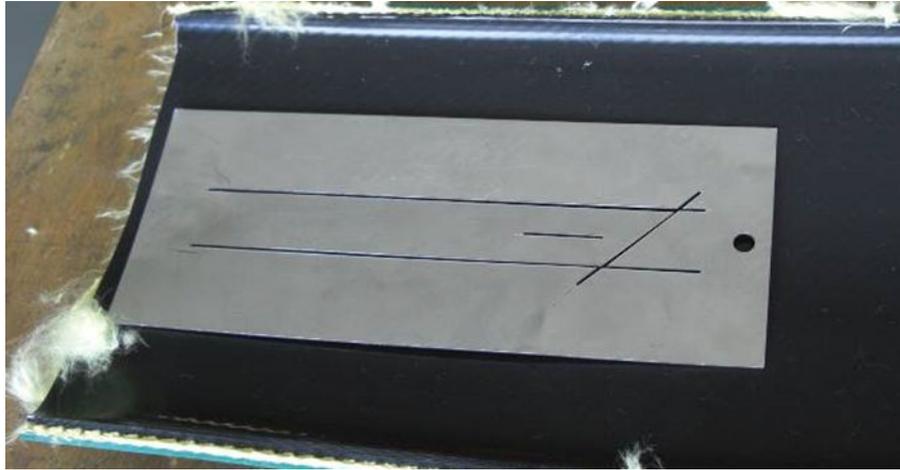


FIG. A2.1 Stencil Plate on a FFRP Section.



FIG. A2.2 Force Gauge Hooked onto the Prepared FFRP Sample

sample to press it tight against the floor and then starts pulling vertically with constantly rising force until the end of the strip has been reached (see Fig. A2.3). For the resulting value of the measurement read the maximum force value of the force gauge

display. Repeat the measurement on the other half tube and for outer layers of both half tubes. For measurement of outer layer adhesion, it is important to measure at staggered positions to the measurement zones of the inner layer.



FIG. A2.3 End of Adhesion Testing

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

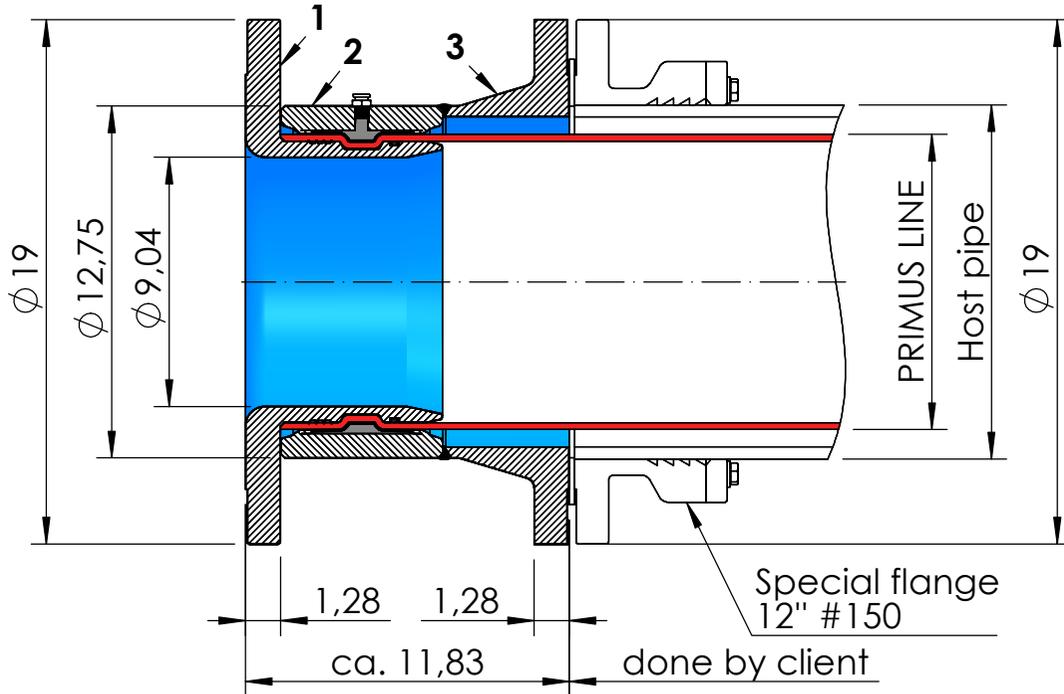
This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), or through the ASTM website (www.astm.org/contact). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; <http://www.copyright.com/>

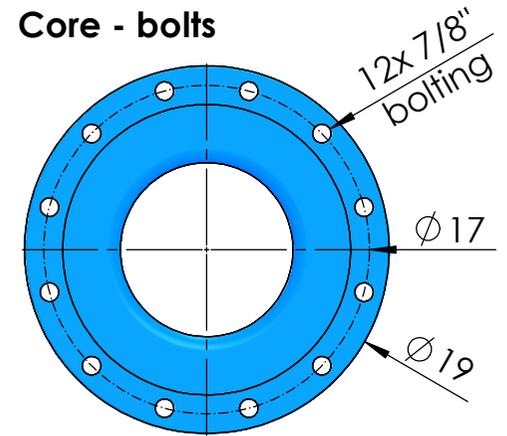
Date, Signature, Stamp

Oliver Lindner

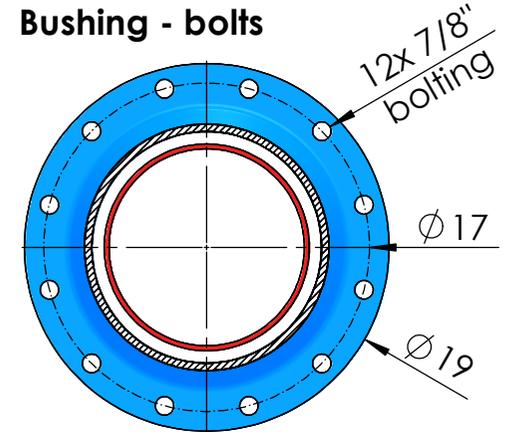
RELEASE



Core - bolts



Bushing - bolts



Dimensions in inches

Material:

Inspection certificate appropriate DIN EN 10204

Coating:

AkzoNobel Resicoat® blue similar to RAL 5015

Customer:

Project:

Constructor:

Site:

Medium:

Operating pressure:

Host pipe:

Existing Flange:



System drawing

Pos.	Piece	Component	Material	Weight	Date	Name
1	1	MD-12"-Coupling-Core-#150-SF	S355J2H	93,5 lbs	Drawn	14.11.2017 Bauer
2	1	MD-12"-Coupling-Bushing	S355J2H	55,8 lbs	Checked	
3	1	Welding Neck Flange ANSI B 16.5 12" #150 RF STD	A105	80,0 lbs		
					Quotation number	
					Rädlinger primus line GmbH Kammerdorfer Straße 16, D-93413 Cham Telefon +49 9971 - 4003 - 100 / Fax +49 9971 - 4003 - 123 primusline@raedlinger.com / www.primusline.com	

Piece: **2**

**Installation of coupling
MD - 12inch - Water - #150**

Drawing number
MD-12inch-W-#150-

Sheet
1 / 1

Release of connector

NSF International

789 N. Dixboro Road, Ann Arbor, MI 48105 USA

RECOGNIZES

Rädlinger primus line GmbH

Germany

AS COMPLYING WITH NSF/ANSI/CAN 61 AND ALL APPLICABLE REQUIREMENTS.
PRODUCTS APPEARING IN THE NSF OFFICIAL LISTING ARE
AUTHORIZED TO BEAR THE NSF MARK.



This certificate is the property of NSF International and must be returned upon request. This certificate remains valid as long as this client has products in NSF's Official Listings for the referenced standards. For the most current and complete Listing information, please access NSF's website (www.nsf.org).

A handwritten signature in black ink that reads "Theresa Bellish".

April 25, 2024
Certificate# C0724790 - 01

Theresa Bellish
Senior Director Municipal Water Systems and NA Region

SECTION 15200

FLEXIBLE FABRIC REINFORCED PIPE

PART 1- GENERAL

1.01. INTENT

It is the intent of this specification to provide for the reconstruction of the designated pressure pipe by the installation of an aramid (Kevlar) Flexible Fiber-Reinforced Pipe (FFRP) within the existing host pipe. Due to the condition of the host pipe the new FFRP shall be designed as a fully independent, non-interactive and loose-fit pipe, not relying on the remaining strength of the host pipe to withstand long-term internal pressure. When the piping system is intended for the conveyance of potable water, the proposed product shall be certified as complying with the requirements of NSF/ANSI 61. Material and installation requirements are specified in the following subsections.

1.02. SUMMARY OF WORK

- A. This work consists of host pipe cleaning, CCTV inspection, and lining the existing **(OWNER SUPPLIED INFORMATION – e.g., 16” diameter cast iron water main)** with the FFRP system; all in accordance with these Specifications, the contract Drawings, manufacturer’s instructions, and any other regulatory requirements. This work requires coordination of work between the Owner, the Engineer, and the Contractor.
- B. The FFRP System includes both the FFRP Liner Material, and the FFRP Connectors.
- C. The work shall be done as described in the Contract Drawings.

1.03. SUBMITTALS

- A. Submit specifications and shop drawings for materials and equipment furnished under this section.
- B. Submit all required documents of Section 2.0.
- C. Submit manufacture’s liner and end connector data/cut sheets.
- D. Submit Manufacture’s engineering project feasibility review, design, and SOP.

- E. Submit Manufacturer's Certificate: Prior to first shipment of FFRP, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the testing specification standards specified herein. Certify that all products furnished meet or exceed specified requirements herein.
- F. Submit manufacturer's requirements for receiving, handling, and storage of materials.
- G. Submit detail description and requirement for preparing existing host pipe for lining, liner and end connector installation procedures.
- H. Submit CCTV Inspection video and report of the existing pipe condition, pipe bends, joints and location of existing valves, tees, and appencies after cleaning, prior to authorization to line.
- I. Submit all field installation and test reports.
- J. Submit warranty from the FFRP manufacturer certifying that the FFRP system shall be free from defects in material and workmanship under normal and proper use and service, for a period of five (5) years after startup and acceptance by the Owner. The Contractor shall provide all labor and materials to repair or replace any defective warranted items specified in this section.

PART 2- PRODUCT, MANUFACTURER/INSTALLER QUALIFICATION REQUIREMENTS

- 2.01. The pipe lining materials shall be Primus Line® as manufactured and supplied by Rädlinger Primus Line, GmbH. or Engineer approved equal. Only pipe lining materials in conformance with the requirements of this contract document shall be considered as an "or equal" for this item.

Approved Manufacturers: Raedlinger Primus Line GmbH

- 2.03. Any product not complying with these specifications for any reason must be pre-approved prior to the formal opening of bids. No later than two weeks before the formal proposal due date, each proposer shall submit to the Owner the required prequalification submittals designated in PART 2, PART 3, and PART 4 of this specification to be considered and approved as an "or equal." The proposer is hereby made aware that the specified product in this contract document has been thoroughly

vetted and has met the technical qualifications and capabilities needed for the project. After the evaluation of the data, the Owner will notify those firms that have produced acceptable submittal packages that they are qualified to furnish proposals for this project and shall be accepted by addendum. The Owner's decision shall be final.

- 2.04. The Installer of the FFRP liner: **(a)** must satisfy all insurance, financial, and bonding requirements of the Owner. **(b)** The installation crew must be trained and certified by the manufacturer of the product being installed and shall submit their certifications. **(c.)** Must have at least five (5) years of active experience installing the intended FFRP system bid and as specified in the contract documents, and **(d.)** at least ten (10) similar installations within the last 12 months of FFRP in a similar application, size and length as indicated in these Contract Documents. Acceptable documentation supporting the above must be submitted to the Owner with the bid.
- 2.05 To be Commercially Proven, the Manufacturer must have had at least 5 (five) years active experience and a minimum of 150,000 linear feet of commercial installation of pressure rated aramid (Kevlar) FFRP products in pressure pipe applications in the United States and Canada. Acceptable documentation supporting the above must be submitted to the Owner with the bid.

PART 3- MATERIALS

- 3.01. The pipe lining system specified herein is a material and methods product as manufactured and specified by Rädlinger Primus Line GmbH, Kammerdorfer Str. 16, 93413 Cham, Germany. Material and installation requirements are specified in the following subsections. The proposer is hereby made aware that the specified product in this contract document has been thoroughly vetted and has met the technical qualifications and capabilities needed for the project.

Approved FFRP Products: Primus Line

- 3.02 Materials for water systems shall meet the appropriate American Water Works Association (AWWA) standards and American National Standards Institute (ANSI) specifications, and be NSF 61 certified, except non-potable water applications as modified by these specifications.

Rädlinger Primus Line

April 2023

15200-3

FFRP Lining

3.03 Materials that are defective, damaged, or otherwise deemed unacceptable for use prior to installation shall be rejected and replaced at Contractor's expense. Materials damaged during installation shall be repaired or replaced as recommended by the Contractor and approved by the Owner.

3.04 Flexible Fabric Reinforced Pipe (FFRP):

A. The FFRP shall be as manufactured and specified by Rädlinger Primus Line GmbH, Kammerdorfer Str. 16, 93413 Cham, Germany to meet the requirements of the pipeline.

A. The FFRP shall be a thermoplastic pipe that is reinforced with aramid (Kevlar) fiber or hybrid reinforcement containing polyester and aramid (Kevlar) fiber woven yarns. No substitutes will be approved.

B. The FFRP Composite shall be constructed of (3) or more distinct layers by a single extrusion process. The layers shall have a distinct individual uniform thickness and meet or exceed the specified internal pressure requirement in Section 4.04.

1. Outer Layer: shall be made of an abrasion-resistant polyethylene PE or TPU. The outer PE layer shall be UV resistant.

2. Reinforcement Layer: shall be a seamless continuous twill of woven aramid (Kevlar®), either one or two layers depending on the required pressure.

3. Inner layer: shall be made of PE or TPU based on media transported.

C. The FFRP shall be clearly marked with the following information:

1. Nominal composite liner diameter.

2. Fluid and maximum operating pressure for the transported fluid.

3. Trade name/trademark.

4. Year, Month, and Day of manufacture in the format YYYY.MM.DD.

5. FFRP batch number.

6. Continuous production run length in feet with the units labelled.

D. There shall be no bonding to the host pipe and no interaction with the host pipe once installed. The outside diameter of the FFRP shall be reduced for a loose-fit within the host pipe with a continuous annular gap and shall be pressure rated to meet or exceed the pressure requirements in Section 4.04 independently of the host pipe being rehabilitated. Close-fit and or interactive products which apply radial stresses on the host pipe will not be accepted.

E. Bend Traversing Capability:

- a. The FFRP shall be capable of passing through bends.
- b. The FFRP shall be capable of passing a 90° bends with approval of the manufacturer.

F. Hydraulic Capacity:

- a. The C-factor for the FFRP shall be 150.
- b. All layers of the FFRP shall be between 0.24 inches to 0.32 inches thick.
- c. The FFRP shall provide a minimum design life of 50 years.

G. The FFRP shall be pressure rated and tested to meet or exceed the pressure requirements independently without interacting with the pipeline being rehabilitated. The pressure class of the FFRP shall be determined by long-term and short-term pressure testing for the core reinforcement layer used. Testing results shall be submitted for verification. See Table 1 for acceptable short-term burst (STBP) minimums.

Table 1. Minimum Short-term Bust of Core Reinforcement

Pressure Class	Diameter inches	Core Reinforcement	Wall Thickness inches (mm)	Minimum Short-term Burst (STBP)
Low	6 - 16 in.	Single-layer Aramid & Polyester	0.24 (6 mm)	435 psi
Medium	6 – 20 in.	Single-layer Aramid	0.24 (6 mm)	580 psi
High	6 – 16 in.	Double-layer Aramid	0.31 (8 mm)	1,189 psi

- H. The FFRP shall be marked for a distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the Manufacturers name, production lot and intended use or identifying symbol. Where applicable, the tube shall be marked "NSF 61" in accordance with the NSF protocol.

3.05 **FFRP End Connectors:**

- B. The FFRP end connectors shall be as manufactured and specified by Rädlinger Primus Line GmbH, Kammerdorfer Str. 16, 93413 Cham, Germany to meet the requirements of the pipeline and the FFRP specified in this contract document.
- C. The End connector shall be constructed of cast iron, carbon steel or stainless steel and be designed to encapsulate and terminate the ends of the FFRP and provide a flanged or welded point for tie-ins.
- D. The end connectors shall be pressure rated for the application and consist of an inside core, an external sleeve and equipped with 150/300 psi ANSI flanges for each section. The connector shall be designed according to the pressure of the FFRP used in the rehabilitation.
- E. FFRP end connectors are manufactures from either cast iron, carbon steel or stainless steel. Connectors are both available with flanges or welded ends. While models with welding ends are not coated, models with flanges have a full-surface, high quality epoxy coating, which provide corrosion protection on all sides. The internal core of the high-pressure connector is made of stainless steel. Flanges used by FFRP comply with EN 1092, ANSI B16.5 of AS4087. All connectors preserve the overall integrity and function of the liner.
- F. The end connectors shall be installed according to the Manufacturer installation specifications by a trained and certified technician.
- G. The FFRP and end connector as part of the lining systems shall be from the same system manufacturer and designed and tested for compatibility. When tested together, the system shall meet or exceed the pressure requirements of the rehabilitated pipeline.

- H. The supplier of all materials shall be an ISO 9001 certified producer or have implemented a quality system similar to that in the ISO 9001 requirements.
- I. All materials that come in contact with potable water shall comply with applicable requirements of NSF/ANSI/CAN Standard 61 and indicated by a current listing by an ANSI accredited certification or testing agency when required by the authority having jurisdiction or other international requirements as applicable.

PART 4- DESIGN REQUIREMENTS

- 4.01 The FFRP shall be designed with the projects design parameters in Section 4.04.
- 4.02 The FFRP shall be designed to assume no bonding to the host pipe wall and withstand all internal pressure without interaction with the host pipe for its design life according to EN ISO 11295.
- 4.03 FFRP shall be designed to be operated as an independent pipe within the host pipe with a minimum design life of 50 years.

4.04 PROJECT DESIGN PARAMETERS

The design of the FFRP shall be based on the following parameters:

Host Pipe Outside Diameter (OD):	Supplied by Owner
Host Pipe Internal Diameter (ID):	Supplied by Owner
Host Pipe Material:	Supplied by Owner
Existing Host Pipe Lining/Coating:	Supplied by Owner
Transported Fluid:	Supplied by Owner
Internal Operating Pressure:	Supplied by Owner
Maximum Operating Pressure:	Supplied by Owner

Test Pressure:	Supplied by Owner
Operating Temperature:	Supplied by Owner
Degree and Radius of Bends:	Supplied by Owner
Position of Bends:	Supplied by Owner
Host Pipe Location & Profile:	Supplied by Owner**

** Site plans provided by the Owner shall indicated and service or branch connections, Tees, valves, hydrants, horizontal and vertical bends, that are located on the host pipe section or length to be rehabilitated.

PART 5- INSTALLATION

5.01. CLEANING AND CCTV INSPECTION

Water necessary for cleaning, disinfection, and flushing will be available, at no cost, from locations (fire hydrants) indicated by the Owner prior to the start of work. The water source provided shall be in close proximity to lines being worked on. The Contractor shall arrange with the Owner, for issuance of an approved combination meter and backflow prevention device. The Contractor shall provide necessary piping or flexible hoses and fittings, for connection between fire hydrant and end of pipe section where water is required. The Owner shall provide a location at no cost to the Contractor (e.g., sanitary sewer, etc.) for proper disposal of water after use.

- A. Cleaning Pipelines: The Contractor shall remove all internal debris and tuberculation from the host pipeline that will interfere with the installation of the FFRP or be detrimental to the final product. ALL WATER shall BE SUPPLIED BY OWNER
- B. Removal of Obstructions and Protrusions: All obstructions and protrusions shall be removed that could be detrimental to the final product and brought to the attention of the Manufacturer, Owner or Engineer prior to the FFRP insertion for correcting. Where inspection reveals an obstruction or protruding weld seam that cannot be removed by

conventional remote equipment and practice, a point repair excavation shall be made to uncover and remove or repair the obstruction prior to the installation of the FFRP.

Host Pipe Failures: If any host pipe failures have occurred prior to the installation of the modified FFRP or are revealed through internal inspection that would inhibit installation or the operation of the pipe they shall be recorded and brought to the owner's representative to evaluate and correct as necessary by external or internal point repairs prior to lining.

- C. Confirmation of Bends: The location, radius and position of bends shall be noted and brought to the attention to the Manufacturer, Owner or Engineer for lining approval.
- D. CCTV Inspection: A video inspection shall log and confirm the adequacy of the cleaning and removal of all debris, tuberculation, obstructions, protrusions and the confirmation of radius of bends within the section.
 - a. All appencies, i.e., valves, tees, services etc. shall be noted on the inspection log and brought to the attention of the Manufacturer, Owner or Engineer for lining approval.
 - b. The inspection video and logs shall be submitted to the Owner for lining approval.

5.02. INSTALLATION

The method for installation shall be the modified sliplining method per AWWA M28 and be in accordance with the latest edition of the Manufacture's Installation Manual. The installation shall be performed by a trained and certified Installer.

FFRP Insertion:

- A. The reel of modified FFRP is positioned at the insertion point (a manhole, chamber, excavated pit or shaft that serves as the point of entrance for the insertion of the modified pipe into the existing pipe) and an appropriately sized winch at the destination point (a chamber, excavated pit or shaft that serves as the point of exit for the modified pipe from the existing pipe).

- B. The winch cable shall be strung through the host pipe and attached to the pulling head with an anti-twist device to prevent the FFRP from twisting while being inserted. The FFRP shall be pulled through the host pipe via the winch located at the destination point.
- C. Pulling forces shall be monitored, recorded and limited so as not to exceed the axial strain limits of the FFRP. The manufacturer shall provide information on the maximum allowable tensile stress of the FFRP and the appropriate pulling device (pulling head or a steel cable) needed for the liner being installed.
- D. Lubricant: The use of a non-toxic lubricant, suitable for drinking water if required, during the insertion is required to reduce friction during the insertion. The lubricant shall not support the growth of bacteria and will not adversely affect the fluid to be transported. The lubricant can be swabbed or sprayed applied or by other means.
- E. The FFRP shall be reverted to its original round shape using forced air pressure when applied to a rubber flow-through plug. The pressure shall be contained within the FFRP by a rubber stopper plug at the termination point and processed in accordance to the Manufacturer's Installation Manual. Internal pressure shall not exceed 14.5 psi.
- F. Upon completion of the insertion and re-rounding process of the FFRP, end connectors shall be installed by a trained and certified technician at the termination ends of the FFRP in accordance to the Manufacturer's Installation Manual and provide a flanged or welded point for tie-ins.

PART 6- HYDROSTATIC PRESSURE AND LEAKAGE TESTING / PRESSURE TESTING

- 6.01 The FFRP shall be subjected to a hydrostatic pressure test in accordance with the owner's requirements. In the absence of owner requirements, a recommended pressure and leakage test shall be at 1.5 the known working pressure or at working pressure plus 50 psi, whichever is less.

6.02 Hydrostat and Main Pressure tests in water and wastewater pipeline applications must be executed with water.

6.03 Hydrotest Preparation & Procedures:

- a. The FFRP-lined section of the pipeline to be tested must be filled with water and air-free. In the case of potable water applications, disinfectants may be added if required.
- b. Apply the pre-determined test pressure, and rest for 5 (five) minutes.
- c. After the 5-minute rest period with pressure drop, the test pressure must be reapplied by pumping. The pumping process must be repeatedly applied with 5-minute rest period intervals. The pressure drop should decline after each repetition compared to the pressure drop measured from the step before.
- d. The test pressure should be reapplied every 5 minutes until the pressure drop “after 5-minute period” is 0.23 PSI (0.016 bar) maximum.

6.04 Main Pressure Test:

- a. Main pressure test shall begin after completion of hydrotest in 6.03.
- b. Main pressure test must be executed for 2 (two) hours.
- c. Main pressure test is considered successful if the pressure loss does not 3 PSI/hour. Hence after the 2-hour period, the pressure loss must not exceed 6 PSI (0.4 bar).

6.05 Leakage Allowance- There is no leakage allowance for a section of FFRP, because when properly made in continuous lengths and installed with approved connectors, it does not leak. Other types of joints or connections in the system may have a leakage allowance. Contact the joint or connection manufacturer for information.

NOTE: If the installed system needs to transport liquid media it shall be assessed with water (hydrostatic pressure testing). If the installed system needs to transport a gaseous media, it should be evaluated with compressed air in accordance with F2786.

PART 7- ACCEPTANCE TESTING

- 7.01 The FFRP shall be deemed acceptable when the installation is performed according to Section 5. and the applicable tests according to Section 6. are satisfied.
- 7.02 The finished lining shall be continuous over the entire length and be impervious and free of any leakage from the pipe to the surrounding ground.

PART 8 - DISINFECTION OF THE PIPELINE FOR POTABLE WATER

- 8.01 In potable water applications the rehabilitated system and all exposed sections of any other pipe and appurtenances of existing pipelines shall be cleaned, disinfected, and verified through bacteriological testing in accordance ANSI/AWWA C651, unless otherwise specified in the contract documents or approved by the Owner.

PART 9 - WATER MAIN RECONNECTION AND CLEAN-UP

- 9.01 Upon project completion, the Owner or Contractor, as specified by contract documents or purchase order, shall return the piping system to service by closure of all access pits with appropriate pipe spools, valves, and other relevant pipe fittings.
- 9.02 Upon acceptance of the installation, the Contractor shall reinstate, the project area affected by the operations.

END OF SECTION 15200