

# **Spoolable Reinforced Plastic Line Pipe**

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## **Addendum 1**

*Section 1.1: The second paragraph shall be changed to the following:*

These products consist of a liner with helically wrapped steel or nonmetallic reinforcing elements and an outer cover. The helical reinforcing elements shall be a single material. Reinforcement tapes, with either metal wire or non-metallic reinforcement fibers and a matrix material, are considered single material. Additional nonhelical reinforcing elements are acceptable. The spoolable reinforced line pipe under this specification is capable of being spooled for storage, transport, and installation. For offshore use, additional requirements may apply and are not within the scope of this document.

*Section 2: The first paragraph shall be changed to the following:*

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies (including any addenda/errata).

*Section 2: The following normative references shall be added:*

API Recommended Practice 17B, *Recommended Practice for Flexible Pipe*

ASTM F2905, *Standard Specification for Black Crosslinked Polyethylene (PEX) Line Pipe, Fittings and Joints for Oil and Gas Producing Applications*

ISO 23936-1, *Petroleum, petrochemical and natural gas industries – Non-metallic materials in contact with media related to oil and gas production – Part 1: Thermoplastics*

NORSOK M-710, *Qualification of Non-metallic Sealing Materials and Manufacturers*

PPI TR-19, *Chemical Resistance of Thermoplastics Piping Materials*

*Section 2: The following normative references shall be removed:*

ASTM F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*

ASTM F2619-13, *Standard Specification for High Density Polyethylene (PE) Line Pipe*

*Section 3.1.1: The following NOTE shall be added:*

NOTE In this document, “batch” refers to manufactured product; “lot” refers to raw material components.

*Section 3.1.46: The following NOTE shall be added:*

NOTE This includes, but not limited to, S-GRE, RTP, and S-GRE and RTP structures lined with PEX.

*Section 4.2.1.2: The 3<sup>rd</sup> paragraph shall be changed to the following:*

PPI TR-19 may be used as a screening tool for evaluating fluid compatibility. ISO 23936-1 and NORSOK M-710 provide a methodology for performing fluid compatibility testing.

*Section 5.2.1: The following paragraph shall be added after the 2<sup>nd</sup> paragraph of the section:*

All qualification tests from 5.2, 5.4, 5.5, and 5.7 shall be carried out on spool pieces comprising the basic pipe body, together with one or more types of end-fitting.

*Section 5.2.3.1: The following paragraph shall be deleted:*

All qualification tests from 5.2, 5.4, 5.5, and 5.7 shall be carried out on spool pieces comprising the basic pipe body, together with one or more types of end-fitting.

*Section 5.2.3.3: The section shall be changed to the following:*

The MPR of the PFR as calculated in 5.2.5 shall be confirmed by burst pressure testing on at least five specimens in accordance with 5.2.3.5. The 97.5 % lower prediction bound of the set of burst specimens shall be calculated using the Student's t-distribution. For the MPR to be confirmed, the calculated 97.5 % lower prediction bound shall be greater than or equal to  $MPR/F_d$ . No single test specimen shall be below  $MPR/F_d$ . Refer to Annex J for the 97.5 % lower prediction bound calculation methodology.

*Section 5.2.4: The 2<sup>nd</sup> paragraph shall be changed to the following:*

The manufacturer shall be required to test all PVs within each product family. All PVs shall be qualified by burst pressure testing on at least five specimens in accordance with 5.2.3.5. The 97.5 % lower prediction bound of the set of burst specimens shall be calculated using the Student's t-distribution. For the PV to be qualified, the calculated 97.5 % lower prediction bound shall be greater than or equal to  $MPR/F_d$ . Refer to Annex J for the 97.5 % lower prediction bound calculation methodology. The permissible failure modes shall be in accordance with 5.2.3.4.

*Section 5.2.5: The second to the last paragraph shall be changed to the following:*

If operating conditions are outside these baseline conditions, an engineering assessment shall be conducted.

*Section 5.3.1: The 1<sup>st</sup> paragraph shall be changed to the following:*

The MPR shall be based on a design factor applied to the long-term hydrostatic pressure of the pipe.

*Section 5.3.1: The following paragraph shall be added as the 4<sup>th</sup> paragraph:*

All qualification tests from 5.3, 5.4, 5.5, and 5.7 shall be carried out on spool pieces comprising the basic pipe body, together with one or more types of end-fitting.

*Section 5.3.3.1: The following 1<sup>st</sup> paragraph shall be deleted (it was moved to 5.3.1):*

All qualification tests from 5.3, 5.4, 5.5, and 5.7 shall be carried out on spool pieces comprising the basic pipe body, together with one or more types of end-fitting.

*Section 5.3.6: The second to the last paragraph shall be changed to the following:*

If operating conditions are outside these baseline conditions, an engineering assessment shall be conducted.

*Section 5.4.2.1: The section shall be changed to the following:*

If field-fittings are used for testing according to 5.2 or 5.3.3, the field-fittings are considered to be qualified. Testing in accordance with 5.4.3 is still required. The only permissible mode of failure when qualifying the field-fittings shall be tensile rupture of the reinforcement.

*Section 5.4.2.2: The section shall be changed to the following:*

Where laboratory test fittings are used in 5.2 or 5.3.3, testing shall be performed in accordance with 5.2.4 or 5.3.5 using field-fittings to confirm that the field-fittings do not adversely affect the MPR. The only permissible mode of failure when testing is performed using laboratory fittings shall be tensile rupture of the reinforcement, and testing in accordance with 5.4.3 is still required.

*Section 5.4.4: The section shall be changed to the following:*

The manufacturer shall specify the allowable temperature cycling range. The manufacturer shall conduct tests on the highest pressure class of the product family using two samples of the smallest and two samples of the largest pipe diameter in the sequence described below:

- a) condition the pipe specimen and the connector to the connector's lowest allowable installation temperature and maintain for a minimum of 2.5 hours;
- b) at this temperature, install the fittings in accordance with the manufacturer's written instructions;
- c) condition the specimen to the MAOT and maintain for a minimum of 2.5 hours;
- d) condition the specimen to the specified lower test temperature (MAOT minus allowable temperature cycling range) and maintain for a minimum of 2.5 hours;
- e) repeat steps b and c for a total of three cycles;
- f) condition the sample at ambient temperature for 2.5 hours minimum; and
- g) perform a leak test at a minimum pressure of 1.5x the NPR for a minimum of two minutes at ambient conditions where there shall be no leakage in two minutes to pass this test.

For bonded pipe constructions, visual examination of the pipe following this test shall show no disbanding.

NOTE The maximum and minimum installation temperature may be different than the maximum and minimum operating temperature.

*Section 5.5.1: The 3<sup>rd</sup> paragraph shall be changed to the following:*

Rapid decompression testing shall be conducted at the highest nominal pressure rating and the maximum design temperature of the product family. Testing shall be performed in accordance with the laboratory test method outlined in Annex C to demonstrate that the design of pipe and fittings is such that there is no collapse, disbondment, blistering, and/or cover blow off.

*Section 5.5.2.1: The section shall be changed to the following:*

The operating MBR shall be specified by the manufacturer. This MBR shall be confirmed by:

- Nonmetallic reinforced pipe shall be subjected to 1000-hour testing in accordance with 5.3.5.2
- Steel reinforced pipe shall be short-term burst tested in accordance with 5.2.3.5 using two test specimens of steel reinforced pipe; each burst pressure shall be greater than or equal to  $MPR/F_d$ .

The manufacturer shall conduct tests on the PFR and on the highest pressure class of the product family using two samples of the smallest and two samples of the largest pipe diameter.

The samples shall be tested by being held in a suitable fixture and maintained at the operating MBR during the test. Retesting shall be in accordance with 5.8.

*Section 5.5.2.3: The 1<sup>st</sup> paragraph shall be changed to the following:*

The effect of handling and spooling on pipe performance shall be demonstrated by conditioning two PFR samples with 10 bending cycles to the operating MBR and confirmed by means of a burst test in accordance with 5.2.4 for steel-reinforced pipe or a 1000-hour test in accordance with 5.3.5.2 for nonmetallic reinforced pipe. Retesting shall be in accordance with 5.8.

*Section 5.5.2.4: The 1<sup>st</sup> paragraph shall be changed to the following:*

If respooling is allowed, precondition two PFR samples to the manufacturer's stated number of allowable bending cycles to the applicable respooling MBR, and confirm by means of a burst test in accordance with 5.2.3.5 for steel-reinforced pipe or a 1000-hour test in accordance with 5.3.5.2 for nonmetallic-reinforced pipe. Retesting shall be in accordance with 5.8.

*Section 5.5.3: The 2<sup>nd</sup> paragraph shall be changed to the following:*

Two samples shall be conditioned at the allowable axial tension load with no internal pressure for 1 hour minimum, followed by 1000-hour testing in accordance with 5.3.5.2 for nonmetallic-reinforced pipe. For steel-reinforced pipe, two test specimens shall be short-term burst pressure tested in accordance with 5.2.3.5 and each burst pressure shall be greater than or equal to  $MPR/F_d$ . Retesting shall be in accordance with 5.8.

*Section 5.5.4: The section shall be changed to the following:*

External load performance shall be characterized on the PFR using ASTM D2412.

*Section 5.6: The 3<sup>rd</sup> paragraph shall be changed to the following:*

Material changes in accordance with Table 3 shall be accompanied by a technical justification of the effect of the change, together with partial requalification according to Section 12 of ASTM D2992-12 for nonmetallic reinforced pipe, except that the distribution of hours to failure shall be a minimum of three points between 100 hours and 999 hours for one set, and minimum of three points greater than 2000 hours for the second set; and burst testing according to 5.2.5 for steel-reinforced pipe. The technical justification shall include documented consideration of whether the change would adversely affect the results of any of the qualification tests required by this specification; if this cannot be determined by analysis, the relevant qualification tests shall be repeated in addition to the partial requalification. If samples fail to pass this test the manufacturer can choose to retest in accordance with 5.8. If the retest samples fail to pass, the changes shall require full qualification according to 5.3.3 or 5.2.3.

*Section 5.6: The 4<sup>th</sup> paragraph shall be changed to the following:*

Changes to the liner or cover as described in Table 3 shall also require accelerated life testing of the end-connection system in accordance with 5.4.3 as a minimum. Color changes are acceptable changes with technical justification (including chemical compatibility with the new color) and partial requalification.

Table 3: The “Liner/Cover” Acceptable Changes shall be changed to the following:

**Table 3—Acceptable Changes with Technical Justification and Partial Requalification**

Liner/Cover	<p>Any change in the qualified polymer compound except by replacement with the same compound from a different vendor.</p> <p>Color changes.</p> <p>A design change in thickness of liner or cover.</p> <p>Compounds not part of the PFR qualification process shall also be tested in accordance with 5.7, unless specifically exempt by the technical justification. All compounds shall be qualified in accordance with Section 4.</p> <p>Any Acceptable Change shall also be tested in accordance with 5.4.3, and, unless specifically exempt by the technical justification, with other tests from 5.4 and 5.5.</p>
Reinforcement	<p>Material supplier</p> <p>Supplier's grade and specification</p> <p>Filament diameter</p> <p>Tow size/configuration</p>
Reinforcement Matrix and Adhesives	<p>Material supplier</p> <p>Grade</p> <p>Thermoset curing system manufacturer</p> <p>Thermoset curing system grade</p> <p>Thermoset T<sub>g</sub></p>
Manufacturing	<p>Transfer of manufacture from one plant to another or additional manufacturing lines or locations.</p> <p>Transfer from prototype to equivalent commercial production manufacturing.</p>

Section 5.7.3: The 1<sup>st</sup> paragraph shall be changed to the following:

The manufacturer shall quote the impact energy resistance of the pipe at minimum installation temperature. Two pipe samples shall be impacted according to the applicable sections of ASTM D2444 using Tup B or an equivalent test method. Following impact testing, the impact energy resistance of the pipe shall be confirmed by means of 1000-hour testing in accordance with 5.3.5.2 for nonmetallic-reinforced pipe. For steel-reinforced pipe, the two test specimens shall be short-term burst pressure tested in accordance with 5.2.3.5, and each burst pressure shall be greater than or equal to MPR/F<sub>d</sub>. Retesting shall be in accordance with 5.8.

Section 5.7.4: The section shall be changed to the following:

The manufacturer shall measure and quote the axial thermal expansion coefficient of the pipe measured over a temperature range of at least 50 °F (28 °C). The pipe test sample shall be a minimum length of 6x the pipe diameter. Pipe test samples may be pre-conditioned. Measurements shall be conducted unpressurized and at the NPR. For applications where OD clearance is critical, the hoop thermal expansion coefficient shall also be determined. The manufacturer shall also conduct a two-sample test on the smallest and largest pipe diameter for the highest pressure class of each product family.

Section 6.4.3: The 2<sup>nd</sup> paragraph shall be changed to the following:

The pressure should be gradually increased, at a rate not greater than specified in the manufacturer's test procedure, to no greater than 110% of the nominal test pressure and constant volume maintained until the

pressure stabilizes. The pressure shall be considered stabilized when the pressure drop is less than 5% in a 1-hour period. Pressure should then be increased to between the nominal test pressure and 110% of the nominal test pressure and maintained for a minimum of one hour, during which time there shall be no leakage or other signs of deterioration. Alternative test procedures are acceptable if agreed between the purchaser and the manufacturer.

*Annex C: The 1<sup>st</sup> paragraph shall be changed to the following:*

In gas or multiphase service, gases will diffuse through the liner and may accumulate at interfaces within the pipe structure. This local accumulation may result in liner collapse, material blistering, multilayer disbondment, or cover rupture. Through a combination of analysis and testing, the manufacturer shall demonstrate that none of the following occur: liner collapse, material blistering, multilayer disbondment, or cover rupture. Testing shall be by the following method.

*Annex C: Section C.1.2 shall be changed to the following:*

Each specimen shall be uniquely identified with a laboratory specimen number, traceable to the production run.

*Annex C: Section C.2.5 shall be changed to the following:*

Remove the specimen from the equipment and remove the end-fittings. Visually examine the pipe sample for cover rupture and liner collapse. Dissect the sample and visually inspect for evidence of disbondment between layers and blistering. Record the results of testing.

*Annex D: Section D.4.2 shall have the following sentence added to the end of the 1<sup>st</sup> paragraph:*

The manufacturer should provide guidance regarding connectors in bends during installation and operation.

*Annex G: Section G.3.3: The 3<sup>rd</sup> paragraph shall be changed to the following:*

To confirm there is no degradation in pipe strength due to the allowable number of cycles, precondition at least two pipe specimens with field-fittings to the allowable number of cycles at the MAOT and successfully pass a short-term burst pressure test in accordance with 5.2.3.5 for steel-reinforced pipe, or pass a 1000-hour constant pressure test according to 5.3.5.2 for non-metallic-reinforced pipe. Retesting shall be in accordance with 5.8. This proof is only required at one pressure which shall be taken between 10,000 and 1 million cycles along the established regression curve and shall not be required for all applications once established.

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- the term “can” is used to express possibility or capability.

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Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, [standards@api.org](mailto:standards@api.org).

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# Spoolable Reinforced Plastic Line Pipe

## 1 Scope

### 1.1 Coverage

This specification provides requirements for the manufacture and qualification of spoolable reinforced plastic line pipe in oilfield and energy applications including transport of multiphase fluids, hydrocarbon gases, hydrocarbon liquids, oilfield production chemicals, and nonpotable water. Also included are performance requirements for materials, pipe, and fittings.

These products consist of a liner with helically wrapped steel or nonmetallic reinforcing elements and an outer cover. The helical reinforcing elements shall be a single material. Reinforcement tapes, with either metal wire or non-metallic reinforcement fibers and a matrix material, are considered single material. Additional nonhelical reinforcing elements are acceptable. The spoolable reinforced line pipe under this specification is capable of being spooled for storage, transport, and installation. For offshore use, additional requirements may apply and are not within the scope of this document.

This specification is confined to pipe and end-fittings and couplings and does not relate to other system components and appurtenances. Where other system components (e.g. elbows, tees, valves) are of conventional construction they will be governed by other applicable codes and practices.

### 1.2 Application of the API Monogram

If the product is manufactured at a facility licensed by API and it is intended to be supplied bearing the API Monogram, the requirements of Annex A apply.

## 2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies (including any addenda/errata).

API Recommended Practice 17B, *Recommended Practice for Flexible Pipe*

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

API Specification 15LE, *Specification for Polyethylene Line Pipe (PE)*, 4th Edition

API Specification 17J, *Specification for Unbonded Flexible Pipe*, 4th Edition

API 1104, *Standard for Welding Pipelines and Related Facilities*

ASME <sup>1</sup> B31.3, *Process Piping*

ASME BPVC, Section IX, *Welding and Brazing Qualifications*

ASTM <sup>2</sup> A370, *Standard Test Method and Definitions for Mechanical Testing of Steel Products*

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<sup>1</sup> American Society of Mechanical Engineers, Two Park Avenue, New York, New York, 10016-5990, [www.asme.org](http://www.asme.org).

<sup>2</sup> American Society for Testing and Materials International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, [www.astm.org](http://www.astm.org).