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Installation and Handling of Spoolable Reinforced Line Pipe

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Contents

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1 Scope

This document establishes recommended practices for onshore installation and handling of spoolable reinforced plastic line pipe (API Specification 15S products) to prevent damage to pipe and field-fittings (couplings, connectors, and end-fittings) in the field environment and to assure assembly integrity prior to use. This document covers handling, layout planning, and installation by direct bury (trench and backfill), surface lay, directional drilling, plowing, and pull through methods. Post installation inspection and field testing are also covered.

2 Normative References

The following referenced document is indispensable for the application of this document. The latest edition of the referenced document applies (including any addenda/errata).

API Specification 15S, *Specification for Spoolable Reinforced Plastic Line Pipe*.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1

connector

Device used to provide a leak-tight structural connection between the end-fitting and adjacent piping (e.g. bolted flanges, clamped hubs, weld necks, and proprietary connectors).

3.2

coupling

Specific type of fitting developed for joining one section of pipe to another (e.g. in-line connector).

3.3

cover

Protective outer sheath of the pipe.

3.4

end-fitting

A mechanical device that forms the transition from the pipe to the connector.

3.5

end user

Entity responsible for operation of the pipeline.

3.6

field-fitting

End-fitting with connector or coupling designed for permanent installation.

3.7

handling MBR

Minimum allowable bend radius the unpressurized pipe is subjected to during any handling.

3.8

joining

The process by which a coupling or end-fitting is installed to create a fluid tight joint.

3.9

lowest allowable installation temperature

Lowest allowable pipe temperature for deployment (e.g. unspooling and installation of fittings).

3.10

manufacturer

Entity that fabricates products according to API Specification 15S.

3.11

operating MBR

Minimum allowable bend radius for the installed and pressurized pipe.

3.12

pre-ripping

The process of loosening the ground with earth moving equipment prior to installation by plowing.

3.13

purchaser

A person, organization, or other entity that is a recipient of a pipeline product provided by a seller under a purchase order or contract of sale.

3.14

purchaser's agent

An installation contractor, inspector, or manufacturer hired by the purchaser to perform specific tasks (e.g. storing, unspooling, joining, handling, inspecting).

3.15

qualified installer

Individual approved by manufacturer to be responsible for any portion of the installation process, including but not limited to inspection, testing, digging, unspooling pipe, and joining field-fittings.

3.16

respooling MBR

Minimum allowable bend radius when respooling the pipe in the factory or the field.

3.17

road crossing

A design feature in pipeline construction that accounts for the placement of a spoolable reinforced plastic line pipe across a road such that vehicular traffic can pass over the pipe without damage to the pipe or vehicle.

3.18

spoolable pipe

Pipe that is flexible enough to be provided as a coil or on a structural reel for transportation.

NOTE For the purposes of this specification, the terms coils, reels, and spools may be used interchangeably.

3.19

spoolable composite pipe

Family of composite reinforced pipes in which the structural layer is flexible enough to enable spooling and unspooling.

4 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

CRA	corrosion resistant alloy
MBR	minimum bend radius
UV	ultraviolet

5 Handling

5.1 Packaging

The following provisions apply for packaging of pipe and field-fittings:

- a) Packaged pipe shall have protective material applied to pipe ends to prevent water ingress and UV damage at pipe terminations;
- b) At a minimum, both free ends of the pipe shall be tightly secured to the reel, coil, or attached supports;
- c) Field-fittings shall be packaged such that they are protected from mechanical damage and corrosion during transport.

5.2 Reel and Coil Transportation and Handling

The following requirements apply to reel and coil transportation and handling:

- a) The manufacturer shall provide the transportation company with:
 - 1. dimensions;
 - 2. weight;

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3. handling MBR in accordance with API Specification 15S;
 4. instructions for securing reels or coils to method of transport that mitigates damage to the product during transport.
- b) The manufacturer shall provide purchaser with written guidelines for safe pre-installation handling of reels and coils, including requirements for special handling and lifting equipment as appropriate.
 - c) Reels and coils shall be transported and handled per the manufacturer specified guidelines.
 - d) Consideration of hazards during transportation and pre-installation handling shall include product weights, height, rollover, chocking, and securing.
 - e) Reels and coils shall be moved by forklift, crane or appropriate vehicle in accordance with manufacturer recommendations.

WARNING Reels shall not be moved by rolling on ground. Serious injury or death could result.

5.3 Receiving Visual Inspection

The following requirements apply to reel and coil receiving visual inspection:

- a) Manufacturer shall provide purchaser with visual inspection guidelines, acceptance criteria, and mitigation requirements (e.g. rejection, cutout, re-rounding) for pipe and field-fittings. At a minimum, the visual inspection guidelines shall include criteria and mitigation requirements for the items listed in Table 1.

Table 1 – Visual Inspection Guideline Template to be Provided by Manufacturer for Receiving Visual Inspection

Component	Inspection Item	Acceptance Criteria	Mitigation
Pipe	Kinks	Acceptance criteria and mitigation requirement columns to be populated by manufacturer	
	Dents		
	Gouges or cuts		
	Bulge or blister		
	Missing protective end caps or covers		
	Outer cover discoloration		
Field-fittings	Corrosion		
	Mechanical damage		
Ancillary items (e.g. risers, venting components, tracer wire)	Corrosion		
	Mechanical damage		
	Missing components		

- b) Purchaser or purchaser's agent shall conduct visual inspection of delivered pipe and field-fittings per manufacturer specified guidelines at time of delivery and as transported;
- c) Visual inspection of all pipe and field-fittings shall be undertaken by a qualified installer;
- d) Any damage shall be mitigated according to manufacturer guidelines before installation.

5.4 Storage

The following requirements apply to storage:

- a) Manufacturer shall provide guidelines for reel, coil, pipe, and fitting storage, as applicable, including:
 - 1. handling MBR in accordance with API Specification 15S;
 - 2. respooling MBR and allowable number of bending cycles in accordance with API Specification 15S;
 - 3. limitations for weathering-related outdoor unprotected storage timeframes if they exist;
 - 4. whether reels or coils should be stored upright or laid on side and if the orientation could result in detrimental effects if stored in an undesirable position for extended periods;
 - 5. information for pipe supplied in coil form if applicable, including maximum allowable number of coils that may be stacked.
- b) Reels and coils shall be stored per manufacturer specified guidelines;
- c) Reels and coils shall be stored on stable surfaces and secured to prevent rolling or overturning;
- d) Reels and coils shall not be stored on unstable or soft terrain such that reel sinking or coil leaning leads to loading on pipe. For storage areas susceptible to environmental conditions that could affect soil stability, the purchaser shall provide means of preventing sinkage (e.g. railroad ties laid perpendicular to the reel cradles). In the case of sinkage, affected pipe section shall be mitigated according to manufacturer guidelines;

- e) Empty reels shall be properly secured to prevent unwanted movement.

6 Pipeline Layout Planning

6.1 Layout design

Manufacturer shall provide purchaser with the product properties and information specified in API Specification 15S Annex I.

NOTE It is important for route planning that the end user has information necessary to conduct a stress analysis, if desired, based on operating temperatures, pressures, and cycling practices.

Purchaser shall comply with manufacturer guidelines in pipeline layout designs and any additional requirements from applicable regulations. Where conflicts exist, the purchaser should contact the manufacturer for assistance.

6.1.1 Design considerations

The following design considerations apply to pipeline layout planning:

- a) During planning of pipeline layout, the system designer should consider the following factors, which may lead to stresses or pipeline movement and accommodate if necessary:
 - 1. thermal expansion and contraction stresses (from anticipated temperature swings including solar absorption of the pipe body);
 - 2. stresses from pipe pressurization;
 - 3. transient pressure effects (e.g. water hammer);
 - 4. environmental hazards (e.g. flooding, fire, animals);
 - 5. soil loading (e.g. vehicle loading, ground movement);
 - 6. stresses from point loading (e.g. rocks or other pipes above or below the pipe);
 - 7. stresses at connections between spoolable and rigid pipe and surface equipment;
 - 8. stresses resulting at pipeline anchor points and pipe supports.
- b) Purchaser shall consider risks associated with pipeline system design, particularly considering failure modes of surface lay pipe relative to a buried design. These failure modes may include but are not limited to third party damage, impingement with another object during pipeline shifting, fire, or freezing.

6.1.2 Bends

Bends in the pipeline system shall be designed with a radius greater than or equal to the operating MBR of the product, including consideration of the potential for pipeline movement or additional stresses.

Field-fittings shall not be installed in the bend zone. The pipe manufacturer shall provide the minimum distance between the beginning of the straight section of the bend and the coupling.

6.1.3 Crossings

The following requirements apply to crossings:

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- a) Manufacturer shall provide design guidance for road and rail crossings and pipeline system designer shall follow manufacturer guidance;
- b) Casing pipe is recommended at road and rail crossings. The need for a casing pipe for road and rail crossings should be determined by the pipeline system designer in consultation with the pipe manufacturer and in accordance with local regulations. Casing size and material shall be sufficient to prevent pipe damage. Where pipe is cased, proper support shall be provided to the pipe at the casing ends to avoid shear loading due to pipe and soil settlement;
- c) Soil compaction should be used in crossing design;
- d) Where possible, avoid use of field-fittings within a crossing.

6.1.4 Risers

The following requirements apply to risers:

- a) Manufacturer shall provide design guidance for risers and pipeline designer shall follow manufacturer guidance;
- b) Use of movement restrictors (e.g. thrust blocks or equivalent methods) should be considered;
- c) Riser location and configuration shall be selected after considering potential axial and combined load threats to the riser. These may include soil settlement, shifting due to pressure/temperature in the line, or other external loads.

6.1.5 Tracer wire

Buried pipe should have a conductive tracer wire marker or other means for line location.

7 Installation and Joining

7.1 General

The following provisions apply for installation and joining of spoolable reinforced line pipe:

- a) Manufacturer shall develop and provide installation and joining guidelines, procedures, check lists, and precautions, as appropriate, made available for review by purchaser;
- b) Manufacturer procedures and guidelines shall provide details on how to properly identify the product, including pipe and field-fittings, using factory applied markings;
- c) Manufacturer shall provide a visual inspection checklist for each of the installation methods described in section 7.3. The checklist can be developed in a single or combined table of each of the stages of pipe installation;
- d) Manufacturer shall have a documented installer qualification program that shall be made available for review by purchaser and regulator, as required. Installation and joining shall only be performed by qualified installers trained and qualified by the pipe manufacturer;
- e) All qualified installers shall have available for inspection qualification documentation with the following information:
 - 1. pipe manufacturer;

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2. qualified installer name;
 3. date of training;
 4. qualification limitations (diameter, joint type, or application);
 5. expiration date.
- f) Installation shall be performed according to pipe manufacturer's written installation guidelines;
- g) Only field-fittings qualified by the pipe manufacturer shall be used for installation;
- h) Qualification for installation of one manufacturer's spoolable reinforced line pipe product is not suitable to certify a qualified installer for any other manufacturer's product.

7.2 Unspooling

The following provisions apply to unspooling:

- a) Manufacturer guidelines shall provide requirements and essential information for unspooling, including:
1. recommendations for unspooling method (vertical vs horizontal, stationary vs moving);
 2. required unspooling equipment for supporting, controlling, lifting, and braking the reels and coils;
 3. maximum allowable axial tensile load;
 4. pulling and anchoring method (e.g. truck, tractor, backhoe, or other vehicle), including considerations for preventing overturning;
 5. description of when, if ever, use of re-rounding techniques should be employed and procedures detailing acceptable re-rounding equipment and pressures;
 6. temperature limitations for unspooling;
 7. disposition of pipe observed to kink during installation;
- b) Loads during unspooling shall not exceed manufacturer specified maximum allowable axial tensile load during installation;
- c) A tension limiting device or tension monitoring device shall be used during installation. Alternatively, manufacturer or qualified installer shall demonstrate by engineering analysis that maximum axial tensile load will not be exceeded, subject to agreement by purchaser;

CAUTION Unpredictable pipe movement can occur when a tension limiting device fails. Appropriate equipment or devices shall be used to prevent injury or equipment damage.

- d) If a tension monitoring device is used, actual axial tensile load should be recorded and retained as part of installation documentation;
- e) Installation area shall be protected from unauthorized entry and personnel shall be out of line of fire of unspooling pipe;

- f) Pipe ends shall be restrained before cutting to prevent release of stored energy;
- g) Handling MBR shall not be violated during unspooling operation and final pipe layout shall comply with manufacturer specified operating MBR.

7.3 Installation methods

7.3.1 Trench and backfill

The following provisions shall apply to products used in trench and backfill installations:

- a) Manufacturer shall provide installation recommendations including:
 - 1. minimum burial depth (depth of cover);
 - 2. trench bedding, if required;
 - 3. limitations on surface loads above pipe after burial;
 - 4. recommendations to avoid backfill materials near the pipe which might cause pipe damage, such as jagged, sharp rocks;
 - 5. guidance on cotrenching with other pipelines or underground infrastructure (i.e. adequate separation distances to avoid loading or thermal interference and provide clearances for future maintenance).
- b) At a minimum, trench bottoms, backfill, and compaction shall comply with manufacturer recommendations;
- c) Trench width shall meet safety requirements.

7.3.2 Boring and directional drilling

The following provisions shall apply to products used in boring and directional drilling applications:

- a) Manufacturer shall provide installation guidelines including:
 - 1. minimum recommended bore diameter;
 - 2. maximum allowable axial tensile load;
 - 3. preparing crossings for pipe pull-through;
 - 4. pipe relaxation;
 - 5. visual inspection of the pipe after pulling;
 - 6. guidance for the effect of elevation and direction changes.

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- b) A sufficient amount of pipe shall be pulled past the bore exit hole to allow for pipe relaxation per manufacturer guidance and to allow for 360° visual inspection of the pipe cover, as agreed between manufacturer and purchaser.

7.3.3 Plowing

The following provisions shall apply to products used in plowing applications:

- a) Manufacturer shall provide installation guidelines including provisions for field-fittings;
- b) Qualified installer should consider pre-ripping the pipeline route, especially where rough ground is anticipated;
- c) Qualified installer shall ensure chute is properly designed for pipe diameter and field-fittings;
- d) Qualified installer shall ensure that plowing equipment that comes into contact with pipe and field-fittings does not cause mechanical damage.

NOTE The tension limiting requirements in section 7.2 do not apply to plowed-in installations.

7.3.4 Pull through installation

The following provisions shall apply to products used in pull through applications:

- a) Manufacturer shall provide installation guidelines including:
 - 1. maximum allowable axial tensile load;
 - 2. visual inspection of pipe and cover after pull through and acceptance criteria;
 - 3. evaluation of host pipe condition and internal diameter (e.g. camera, test section, pigging);
 - 4. disposition of pipe observed to kink during installation;
 - 5. guidance for type and application of lubricants to reduce pull through tension, if applicable;
 - 6. pipe relaxation time period, if applicable;
 - 7. guidance for use of field-fittings that reside in host pipe.
- b) Pull length calculations and determination of bell hole locations shall be conducted per manufacturer guidelines;
- c) Interior surface of host pipe shall be free of upsets (e.g. welding slag, excessive weld root penetration, dents, gouges) which could damage the pipe;
- d) Pulling ropes and cables shall be inspected for compliance per manufacturer guidance;
- e) Handling MBR shall not be violated during pulling operation;
- f) Final pull through layout shall not violate operating MBR;

- g) If wire rope is used as the pull line, a swivel should be installed to prevent the wire rope from applying torque to the pipe as it is pulled during installation;
- h) An axial tensile load indicator system which provides real-time read out of axial pulling during installation should be utilized. Tension limiting devices may also be used. Alternatively, manufacturer or qualified installer shall demonstrate by engineering analysis that maximum axial tensile load will not be exceeded, subject to agreement by purchaser. Actual or calculated axial tensile load shall be retained as part of the installation documentation;
- i) A sufficient amount of pipe shall be pulled past the bore exit hole to allow for pipe relaxation per manufacturer guidance and to allow for 360° visual inspection of the pipe cover, as agreed between manufacturer and purchaser;
- j) Pipe shall be evaluated per visual inspection guidelines and inspection criteria provided by the manufacturer;
- k) Pipe shall be suitably restrained at both ends of the host pipe to prevent pressure- or temperature-induced expansion loads or deformation beyond allowable limits during operation;
- l) Manufacturer shall provide guidance for how to retrieve, repair, or replace the pipe in case of damage during installation.

7.3.5 Surface lay installations

The following provisions shall apply to products used in surface lay applications:

- a) Manufacturer shall provide installation guidelines, including:
 - 1. pipe restraint requirements;
 - 2. guidance for the support of field-fittings, if applicable;
 - 3. types and acceptable spans between pipe rack supports, including recommendations for support to pipe interface materials, if applicable.
- b) Ground condition shall be verified to prevent damage to pipe. Pipe shall be laid clear of any surface obstructions (trees, shrubs, rocks) that could wear against the pipe;
- c) Where surface lay pipe crosses a road, devices shall be installed to allow vehicles to cross the pipeline without damage or impact to the pipe or vehicle. Road crossings shall be large enough to hold the pipe and field-fittings and shall freely accept the pipe or field-fitting width without creating point loads or creating abrasion damage during operation. At a minimum, the road crossing design shall consider the following:
 - 1. structural strength – the road crossing should be engineered and constructed with sufficient strength to handle the expected external loads and clearance for crossing traffic;
 - 2. placement – road crossings near intersections and curves shall provide sufficient distance to allow roadway traffic to safely use the road crossing;
 - 3. markings – pipeline crossings in open terrain (e.g. desert) should be clearly marked with flags or other indicators.

7.4 Joining

The following requirements apply to joining:

- a) Manufacturer shall specify and qualified installer shall document key process parameters for joining, as applicable, including:
 - 1. temperature limitations;
 - 2. torque values;
 - 3. fusion temperatures;
 - 4. insertion depths;
- b) Manufacturer shall also provide maintenance guidance for tools required for proper installation;
- c) Qualified installer shall properly inspect condition of joining equipment and address maintenance requirements of joining equipment prior to initiating the joining process;
- d) Only field-fittings and tools (e.g. for crimping and swaging) from the pipe manufacturer shall be used for joining;
- e) Only joining equipment (e.g. for crimping and swaging) specified by the pipe manufacturer shall be used;
- f) For field-fittings that require welding to adjacent metallic pipe, pipe should be welded to the field-fitting before joining the field-fitting to the spoolable pipe. If welding after joining is necessary, the manufacturer shall specify and qualified installer shall comply with all measures to prevent damage to the spoolable pipe (e.g. length requirements, temperature controls, pipe angles);
- g) Qualified installer shall conduct the following activities to prepare the pipe and field-fittings for joining:
 - 1. verify the compatibility of the pipe and field-fitting in accordance with manufacturer specifications and purchase order;
 - 2. verify the field-fittings are free of defects or damage that would compromise pipeline integrity, in accordance with manufacturer acceptance criteria;
 - 3. inspect the pipe for anomalies or damage in accordance with manufacturer acceptance criteria;
 - 4. prepare pipe end(s) to receive the field-fitting in accordance with manufacturer installation guidelines.
- h) Joining shall be performed according to the pipe manufacturer's written guidelines.

8 Post-installation visual inspection

8.1 After unspooling

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Following unspooling, but before pipe burial, qualified installer and purchaser or purchaser's agent shall perform visual inspection per manufacturer specified checklist to:

- a) Identify any area that has violated operating MBR (e.g. with radius templates);
- b) Identify exterior damage to pipe (e.g. kinks, dents, ovalization, gouges, etc.);
- c) Identify any additional factors listed on manufacturer checklist.

Violations observed during visual inspection shall be corrected or repaired per manufacturer guidelines. Visual inspection records shall be documented by purchaser or purchaser's agent and retained by end user.

8.2 After field-fitting installation

Following field-fitting installation (before or after burial), purchaser or purchaser's agent shall perform a visual inspection per manufacturer specified checklist to:

- a) Identify damage to field-fittings;
- b) Confirm annulus venting components (vent valves, tubing), as applicable, are properly installed per manufacturer recommendations and that venting components are free of obstructions;
- c) Ensure compliance with manufacturer specified length of straight pipe run from each end connection
- d) Check for alignment between adjacent pipe, field-fitting, and pipe;
- e) Identify any thermal damage to pipe caused by hot work during field-fitting installation.

Violations observed during visual inspection shall be corrected or repaired per manufacturer guidelines. Visual inspection records should be documented by purchaser or purchaser's agent and retained by end user.

9 Testing

9.1 Hydrostatic pressure testing

The following requirements apply to hydrostatic pressure testing of installed pipe:

- a) Hydrostatic pressure testing of field installed pipe shall be undertaken to verify the integrity of pipe and field-fittings;
- b) Suitable safety precautions shall be taken, considering the stored energy involved in pressure testing;
- c) Pneumatic pressure testing may be preferred in certain situations, in which case additional safety precautions are warranted;
- d) Manufacturer shall provide guidelines for pressure testing, including:
 - 1. minimum and maximum test pressures and pressurization/depressurization rates;
 - 2. requirements for conditioning pipe prior to hydrostatic pressure test;
 - 3. minimum hydrostatic pressure test hold duration;

4. specific guidance for testing complex systems (e.g. movement restrictors at connections to steel pipe);
 5. guidance for adequate restraint during testing;
 6. guidance for dealing with the effect of elevation changes on the applied test pressure;
 7. guidance for interpretation of pressure decreases from pipe relaxation.
- e) Applicable regulations shall define test pressures and durations. The hydrostatic pressure test plan shall be reviewed with the manufacturer if the testing parameters are in excess of manufacturer specifications;
 - f) Connections between spoolable and rigid pipe shall be included in the hydrostatic pressure test. If it is not possible to include adjacent rigid pipe, exclusion shall be document and justified;
 - g) The test pressure shall be limited by the lowest rated component in the system being tested;
 - h) Hydrostatic pressure testing shall be conducted after backfilling as backfilling can cause damage to pipe. The manufacturer may request that field-fittings are left exposed until after the hydrostatic pressure test has been completed. If the hydrostatic pressure test is performed before backfilling, a leak test of the annulus, if applicable, should be performed after backfilling to verify integrity of the cover;
 - i) For field-fittings using thermosetting resins, hydrostatic pressure testing shall be carried out only after minimum cure time;
 - j) Repair after hydrostatic pressure test failure shall be performed in accordance with manufacturer's recommendations for and followed by additional hydrostatic pressure test to verify repair;
 - k) Failed hydrostatic pressure tests and likely reasons for failure shall be documented by party conducting hydrostatic pressure testing operation and retained by end user.

9.2 Leak and flow testing of annulus

If applicable, manufacturer shall provide guidance for testing cover integrity and adequate annular flow. Purchaser or purchaser's agent shall verify cover integrity after field-fitting installation.

9.3 Cathodic protection

Manufacturer shall provide guidance for mitigating corrosion of field-fittings (i.e. by installation of cathodic protection, use of CRA field-fittings, field applied protective coatings, or viscoelastic tape).

If applicable, purchaser or purchaser's agent shall verify performance of the cathodic protection system.

If applicable, manufacturer shall provide guidelines for proper placement of welded anode lead wires to the field-fitting.