Recommended Practice for Care and Use of Fiberglass Tubulars

API RECOMMENDED PRACTICE 15TL4
SECOND EDITION, MARCH 1999

REAFFIRMED, OCTOBER 2013

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

This recommended practice is under the jurisdiction of the API Subcommittee on Fiberglass and Plastic Tubulars.

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CONTENTS

Recommended Practice for Care and Use of Fiberglass Tubulars

1 Scope

The purpose of this publication is to provide information on the transporting, handling, installing, and reconditioning of fiberglass tubulars in oilfield usage.

Note: No provision of this Recommended Practice shall be cause for rejection of fiberglass tubulars provided the threads are in accordance with the requirements of the applicable product specification.

Trouble-free service and maximum safety should result if this Recommended Practice is followed. Fiberglass tubulars differ in properties from metallic tubular goods and different installation techniques are required.

Note: These recommendations are applicable to normal situations. Exceptional conditions may warrant different practices. It is not intended that these practices conflict with any regulatory code.

It is suggested that the selection of thread compound be given careful consideration by the user bearing in mind that a satisfactory compound should possess certain properties, the major of which are (1) to lubricate the thread surfaces to facilitate joint make up and break out without galling and (2) to seal voids between mating thread surfaces and effectively prevent leakage. Thread compounds have a significant impact on the performance of tubulars, especially under combined loading conditions. The manufacturer's recommended thread compound, which has been qualified in accord with the API product specification, should be used.

CAUTION: The material safety data sheets for thread compounds should be read and observed. Store and dispose of containers and unused compound in accord with appropriate regulations.

2 References

This recommended practice includes, by reference, either in total, or part, the latest edition of other API, industry and government standards as listed:

API

Spec 5B	*A Specification for Threading, Gauging and Thread Inspection of Casing, Tubing and Line Pipe Threads*
RP 5B1	*Gauging and Inspection of Casing, Tubing and Line Pipe Threads*
Spec 15LR	*A Specification for Low Pressure Fiberglass Line Pipe*
Spec 15HR	*A Specification for High Pressure Fiberglass Line Pipe*

ASTM[1]

D1599	*A Test Method for Short-Time, Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings*
D2105	*A Test Method for Longitudinal Tensile Properties of Reinforced Thermosetting Resin Pipe and Tube*
D2584	*A Test Method for Ignition Loss of Cured Reinforced Resins*
D3839	*A Standard Practice for Underground Installation of Flexible Reinforced Thermosetting Resin Pipe and Reinforced Plastic Mortar Pipe*

AWWA[2]

C-950	*AWWA Standard for Fiberglass Pressure Pipe*

3 Units of Measure

A decimal/inch system is the standard for the dimensions shown in this document. Nominal sizes will continue to be shown as fractions. For the purposes of this recommended practice, the fractions and their decimal equivalents are equal and interchangeable. Metric conversions are described in Appendix F.

4 Packaging

Fiberglass tubulars shall be packaged so that the body and connections are protected during shipping, unloading, storing, and handling. The manufacturer shall apply external and internal protectors of such design, material and mechanical strength to protect the threads, and/or ends, of the tubular and coupling from damage under normal handling and transportation. External protectors shall cover the full length of the thread, or bonding area, on the pin and the internal protectors shall cover the equivalent total thread length of the internal thread, and/or bonding surface. Protectors shall exclude foreign matter such as dirt from the threads and from the interior of the tubular. The protectors shall contain no compounds capable of damaging the threads or promoting adherence of the protectors to the threads or bonding surfaces. Refer to the appropriate product specification.

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[1]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959.

[2]American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado 80235.

5 Transportation, Handling and Storage

5.1 GENERAL

Fiberglass tubulars in general, and threads in particular are made with precision and require careful handling. Whether new, used or reconditioned, they should always be handled with protectors in place.

5.2 TRANSPORTATION

5.2.1 Observation of the following practices will assure that damage to the product does not occur. The following precautions should be taken for truck transportation:

a. Trucks that haul tubulars should be the flatbed type and not pole trailers. Bed length of the trailer should be sufficient so that no overhang occurs.
b. The use of stripping under the bottom layer and between each layer is recommended to prevent damage to the tubulars, as well as to keep them from shifting. For nominal 30 foot lengths, a minimum of four (4) stripping material supports are recommended. Stripping material should not be placed on the transition or upset areas of the tubing. Stripping material on the truck bed should be no more than six (6) feet apart, oriented perpendicular to the tubular body and aligned vertically, of uniform thickness within each layer and free of protruding nails. It should be a material softer than the tubular. Stripping must be placed as near to the end of the tubular as possible and still maintain vertical alignment.
c. Load tubulars with all couplings (box ends) on the same end of the truck.
d. Care should be taken to prevent chafing of joint shoulders on adjacent joints.
e. Suitable tie-downs, such as woven cloth straps, should be used to secure the load. Caution should be used to prevent damaging the tubulars when securing the load. The manufacturer shall endeavor to locate the tie-downs such that bending of the tubulars is minimized.

For shipments other than by truck, packaging, loading and protection procedures shall be agreed upon between the purchaser and the manufacturer.

5.3 HANDLING

The following precautions should be observed in handling fiberglass tubulars:

a. Prior to unloading, make sure that the protectors are tightly in place. Inspect the body for delaminations (bruises), crazing, indentations, contaminations, imbedments, or tears. Upon request, the manufacturer shall furnish descriptive criteria pertaining to visual inspection.
b. Avoid rough handling which might damage the body of tubulars of threads. When tubulars are being loaded or unloaded, each length of bundle should be handled individually. Never unload fiberglass tubulars by pulling out the side stakes or sideboards and allowing the tubulars to roll off the trailer. Do not use hooks for lifting as the ends of the tubular can be damaged. Woven cloth slings with spreader bars are acceptable for unloading.

Note: Caution should be exercised that fiberglass tubulars are not unduly flexed during any handling operation. Undue flexing occurs when the bend radius is smaller than the manufacturer's recommended minimum bend radius.

5.4 STORAGE

The following precautions are recommended for storage of fiberglass tubulars:

a. Do not pile the tubulars directly on the ground, rails, steel or concrete floors. Racks normally used for steel pipe and tubing are not suitable for fiberglass tubulars.
b. The use of stripping under the bottom layer and between each layer is recommended to prevent damage to the tubulars, as well as to keep them from shifting. For nominal 30 foot lengths, a minimum of four (4) stripping material supports are recommended. Stripping material should not be placed on the transition or upset areas of the tubing. Stripping material should be no more than six (6) feet apart, oriented perpendicular to the tubular body and aligned vertically, of uniform thickness within each layer, and free of protruding nails. It should be a material with a surface that is softer than the fiberglass tubulars. Stripping must be placed as near to the end of the product as possible and still maintain vertical alignment.
c. Stagger adjoining lengths of tubulars in the tiers an amount approximating the length of the coupling.
d. Block tubulars by nailing 1 x 2 (in.) or 2 x 2 (in.) wooden blocks at both ends of spacing strips.
e. Tubulars should not be stacked higher than is convenient for safety, ease of inspections, loading and unloading.

6 Fiberglass Tubing

6.1 PREPARATION AND INSPECTION BEFORE RUNNING

6.1.1 Inspection criteria for fiberglass tubing differs from the criteria used for steel tubulars. It is suggested that in preparation for visual examination of fiberglass tubing, the individual user familiarize himself with the inspection practices employed by the manufacturers, and summarized in Appendix E, along with the definition of defects contained in Table E-1.

6.1.2 All fiberglass tubing, whether new, used or reconditioned should always be handled with thread protectors in place. Tubing should be stored at all times on racks or on wooden or metal surfaces free of rocks, sand, or dirt. If lengths of tubing are dragged in the dirt, the threads should be cleaned, inspected and serviced again as outlined in 6.1.9.

6.1.3 Before running in the hole, tubing interiors may be visually inspected and drifted with an API drift mandrel.

6.1.4 It is recommended that the user select the joint of tubing to be installed at the top of the string before starting to run in the hole. Because of the permissible tolerance on the outside diameter immediately behind the tubing upset difficulties may occur when wrap-around seal-type hangers are used with fiberglass tubing manufactured on the high side of the tolerance.

6.1.5 Elevators should be in good repair, and should be visually inspected and have links of equal length. Latch fittings should be complete.

6.1.6 Standard elevators are recommended for all threaded and coupled installations. For integral joint installation, slip type elevators, without a setting ring, are recommended because integral joint tubing will wedge in standard elevators as weight increases beyond 5,000 lb. Below this weight, standard elevators may also be used.

6.1.7 Spider slips should be examined before using to see that they are working together, so that they will not crush the tubing.

6.1.8 Tongs (wrenches) should be designed for fiberglass and set up for the specific dimensions of the product being run. Powered tongs should be used with extreme caution. The manufacturer's recommended make-up procedures for new tubing should not be exceeded. The use of pipe wrenches is not recommended.

Note: Injurious slip and tong marks should be avoided by not using rig tongs.

6.1.9 The following precautions should be taken in the preparation of threads:

a. Immediately before running, remove protectors from both ends and carefully inspect the threads. Those found to be damaged, even slightly, should be laid aside unless satisfactory means are available for correcting thread damage. Refer to the visual inspections standards of Table E-1, Appendix E, for allowable limits.
b. Brush dirty threads with a clean wire brush. This is extremely important on tubing that has been in prior service.
c. Wash dirty threads. Dry the threads with clean tissues or rags. Any liquid remaining in the root of the thread will prevent good lubrication.

CAUTION: The manufacturer's directions, precautions, and Material Safety Data Sheets for cleaning fluids should be read and observed. Observe appropriate regulations relative to disposal of used cleaning fluids.

d. The length of each piece of tubing shall be measured prior to running. A steel tape calibrated in decimal feet to the nearest 0.01 ft should be used. The measurement should be made from the outermost face of the coupling or box to the position on the externally threaded end where the coupling stops after make up. The total of the individual lengths so measured will represent the unloaded length of the tubing string. The actual length under tension in the hole can be obtained by consulting the manufacturer.
e. Place clean protectors on the pin end of the tubing so that the threads will not be damaged while rolling tubing onto the rack and pulling into the derrick. Thread protectors may be cleaned and reused for this operation.

6.1.10 The tubing should be lifted into the derrick carefully, tailing the pin end, to prevent damage to the tubing, couplings, and protectors.

6.2 STABBING, MAKING UP AND LOWERING

6.2.1 Do not remove thread protector from the pin end of tubing until ready to stab.

6.2.2 Center rig over well bore prior to running. Check alignment periodically on deep wells.

6.2.3 Before stabbing, apply sufficient thread compound to fill the thread profile on both the pin and the box. Use the thread compound qualified by the manufacturer. The brush, or utensil, used in applying thread compound should be kept free of foreign matter and the compound should never be thinned.

Note: PTFE (Teflon™) tape is not required to affect a seal with API 8-round threads. Its use on tubing is not recommended because its use tends to increase the potential for thread damage during pulling operations.

6.2.4 Stab vertically, with the assistance of a man on the stabbing board. Care should be exercised to prevent misalignment or tilting after stabbing. If either occurs, the tubing should be lifted and the pin and box inspected for damaged threads. If damage has occurred, the threads must be cleaned to remove any fragments, reinspected in accord with Appendix E, Table E-1, and thread compound reapplied. Intermediate supports may be placed in the derrick to limit bowing of the tubing.

6.2.5 Make up joints hand tight after stabbing. Apply torque slowly to make up the connection to the recommended torque or positions values established by the manufacturer.

Note: The torque required for make up of fiberglass tubing is significantly lower than the torque required for steel tubulars.

6.2.6 Spiders, slips, and elevators should be cleaned frequently and slip inserts should be kept sharp.

6.2.7 Finding bottom should be accomplished with extreme caution. Do not set tubing down heavily.

6.2.8 When lowering tubing into the well bore, care should be exercised to avoid abrupt stops which can result in dynamic tensile loadings. Stop tubing motion prior to setting the slips. Exercise caution when running couplings through slips and blow-out preventions.

6.3 PULLING TUBING

6.3.1 During disengagement from bottom hole tools and equipment, extreme caution is required to assure that tubing is free to exit the hole. A calibrated weight indicator should be used. Fluid levels in the tubing and casing annulus should be equalized by filling or swabbing. The live load of the tubing in the fluid should be determined so the rig operator is sure he has tubing weight during the first lift. Never exceed the manufacturer's rated tensile loading to get loose from bottom hole tools.

6.3.2 If tubing is stuck, try lowering the tubing, to one half the string live load, then lifting (with rotation if required) up to manufacturer's maximum recommended tensile rating. Several cycles may be required if a lot of sludge or sediment has accumulated at the bottom of the hole. If tubing remains stuck at the bottom, it is more economical to shoot or mill off the tubing at the joint above the bottom hole connection than to pull the string apart; more of the string will be saved and there will likely be fewer fishing trips required.

6.3.3 Break-out tongs should be positioned close to the coupling. Hammering on the coupling, or box, to break out a joint is a potentially damaging practice. If tapping is required, use a wooden slat (2 x 4) between the hammer and fiberglass. Tap lightly at the middle of the engaged thread to be broken out, and completely around the threaded joint. Do not tap near the end, or on opposite sides only. Tapping should be done while applying a constant break out torque.

6.3.4 Care should be exercised to disengage all of the thread before lifting the tubing out of the coupling (box). Do not jump tubing out of the coupling (box) or continue to rotate after last thread is disengaged.

6.3.5 Tubing stacked in the derrick should be set on a firm wooden platform. Protect threads from dirt or damage when the tubing is out of the hole. The use of pin end thread protectors is recommended.

6.3.6 Tubing set back in the derrick should be properly supported to prevent undue bending. Tubing $2^{3}/_{8}$-in. O.D., and larger, can be pulled in stands approximately 60 feet long (doubles). Stands of tubing 1.900-in. O.D. or smaller, should have intermediate support. Stands longer than 60 ft (i.e. triples) are not recommended.

6.3.7 Prior to leaving location, always firmly tie a set back of tubing in place.

6.3.8 Make sure threads are undamaged, clean, and well-coated with compound before re-running.

6.3.9 Distribute joint and tubing wear by reversing the string each time the tubing is pulled. That is, the first joint removed from the well should be the first joint to be run into the well. When pulling doubles, alternate the break-out point to distribute wear on the connections.

6.3.10 All threads should be cleaned and clean protectors should be placed on the tubing before it is laid down.

6.3.11 Before tubing is stored or re-used, tubing and threads should be inspected and defective joints segregated.

6.3.12 If tubing is being retrieved because of a failure, it is imperative to future prevention of such failures that a thorough study be made. Every attempt should be made to retrieve the failed portion in the "as failed" condition. When analysis reveals some facet of product quality to be involved in the failure, the results of the study should be reported to the API office in Washington, DC.

6.4 COMPLETION PRACTICES

6.4.1 Fiberglass tubing should always be left in tension.

6.4.2 Prior to running fiberglass tubing in steel casing, the casing should be scraped and circulated to remove scale or other restrictions in the ID that may impair downhole operations. If the casing size is not definitely known, a gage ring or caliper should be run.

6.4.3 When making fiberglass pipe to steel connections, inspect the steel threads for burrs that could cut the fiberglass threads. Remove burrs from the steel threads by chasing with a threaded steel fitting. The preferred steel to fiberglass connection is fiberglass pin to steel coupling (box).

Note: Fiberglass threads are typically long form 8-round and most downhole steel tools are short form 8-round. Ensure that the coupling and pin thread length are compatible. When connecting long form to short form 8-round, remove threads from the pin using Table 1 as a guideline (See also API Spec 5B and the applicable product specification).

6.4.4 Fiberglass tubing installed in open hole completions should be equipped with centralizers, jet plugs, or tubing anchors without rubber elements to prevent free swinging and unscrewing.

6.4.5 Permanent, or drillable packers used with fiberglass tubing set with a latch in assembly are preferred. Do not use compression set packers.

6.4.6 Tension packers should be set with a weight indicator to obtain proper tension. Packers should be equipped with soft rubber (50 to 65 Durometer A) elements.

6.4.7 Fiberglass tubing used in rod pumping installations must be equipped with tubing anchors to minimize breathing and buckling.

6.4.8 Sucker rods installed in fiberglass tubing should be plastic coated. Nylon or hard rubber rod guides should be used to minimize tubing wear.

6.4.9 Couplings (box ends) on fiberglass tubing are generally larger than equivalent steel sizes and care should be taken

to provide adequate clearance, e.g, for cables in submersible pump installations.

6.5 FISHING

Standard oilfield fishing tools (spears, overshots, etc.) can be utilized when fishing is necessary. Care must be taken to fit the tools to the outside diameter and inside diameter of the tubulars. Fiberglass tubular dimensions do not match API dimensions for steel tubulars.

6.6 MILLING AND DRILLING

A standard three (3) cone rock bit has been shown to be a reliable means to drill up fiberglass tubulars. Drilling rates should be governed to produce cuttings small enough to pass through surface piping restrictions (i.e., valves and elbows).

6.7 CAUSES OF FIBERGLASS TUBING PROBLEMS

The more common causes of problems are as follows:

a. Improper selection for strength and life.
b. Insufficient inspection at the mill or in the field.
c. Careless loading, unloading, and cartage.
d. Damaged threads resulting from protectors loosening and falling off or improper stabbing.
e. Lack of care in handling and storage.
f. Worn-out or improper handling equipment and tools.
g. Improper procedures in running, lifting and pulling tubing.
h. Compression loads or alternating tension or compression loads.
i. Rod cutting and sucker rod breakage.
j. Excessive expansion and contraction due to temperature and pressure fluctuations.
k. Dropping a string, even a short distance.
l. Exceeding internal or external pressure ratings.
m. Erosion from entrained abrasives.
n. Leaky joints under an internal or external pressure are a common problem and may be due to:

1. Improper thread compound and/or application.
2. Dirty threads, or threads contaminated with foreign material.
3. Under-or over-torquing.
4. Galled threads.
5. Damaged couplings.
6. Exceeding axial tensile strength.
7. Worn-out threads.

7 Line Pipe

7.1 DITCH PREPARATION

7.1.1 The ditch should have vertical sides and be made sufficiently deep so that a protective bedding layer of sand or compacted fine grain soils can be used. The bedding of the trench should be as uniform and continuous as possible. Unevenness, which will cause nonuniform bearing on the pipe, should be leveled. Care should be taken to minimize damage resultant from rocks, and other materials, which might fall into the ditch. Refer to AWWA Standard C-950, or ASTM D3839, for additional information on ditch preparation.

7.1.2 Horizontal and vertical changes which should require sharper bends than recommended by the manufacturer must be made with appropriate fittings and the ditch excavated accordingly.

7.1.3 When installing fiberglass pipe in a conduit, necessary precautions to prevent damage should be observed. Precautions include the use of saddles, or rigid centralizers, to center the pipe in the conduit. Trench soil at the casing end must be compacted, otherwise the pipe may shear. Pipe should be protected from rough sharp edges at the end of the casing.

7.1.4 Thrust blocks may be needed in some situations where the line changes direction, reduces, dead ends or where excessive expansion variations are anticipated. Follow the manufacturers recommendations. Refer to AWWA Standard C-950 or ASTM D3839, for additional information.

7.1.5 When multiple lines are laid in a single ditch, the manufacturer's recommendations on lateral spacing and ditch width should be requested and followed.

7.2 ASSEMBLY

7.2.1 General

The method of assembly varies somewhat according to the joining system being used. The following provides guidelines for each of the API standard joint types:

a. Six-inch and larger line pipe is usually assembled in the ditch. Smaller diameter pipe is normally assembled on the surface and walked into the ditch.

CAUTION: Do not exceed the minimum bending radius of the pipe as it is lowered into the ditch.

b. Protect the joints during all handling operations. Joints to be adhesively bonded should be protected again exposure to ultraviolet rays during handling operations.

7.2.2 Adhesive Bonded Joints

All adhesive bonding should be performed using a written bonding procedure that has been qualified by test for the application. Personnel doing the bonding should be trained, and qualified by test, to perform the bonding operations. Qualified written procedures, and training assistance, are available from the manufacturers of the fiberglass pipe.

Appendix A provides guidelines for preparation of a written fiberglass pipe bonding procedure.

Appendix B provides guidelines for preparation of a written procedure for qualification of bonding personnel.

Appendix C is a sample bonded-joint inspection sheet.

Appendix D provides guidelines for preparation of a written line pipe repair procedure.

In bonding fiberglass pipe it has been found that exposure of the surfaces to be bonded to ultraviolet rays, for relatively short periods of time, can significantly reduce joint strength unless the joint is sanded and retapered. Bells should be protected from exposure until just before the bonding is to take place.

In bonding matched taper bell and spigot joints, product from different manufacturers should not be interchanged. The objective is to obtain a thin uniform bondline. Excessive adhesive will result in a loss of joint strength.

CAUTION: Some components used in the bonding operations may cause skin irritation or burns. Inhaling the vapors should be avoided. The manufacturer's precautions and Material Safety Data Sheets should be read and followed closely. Store and dispose of the container and spent materials in accord with applicable regulations.

7.2.3 Threaded Joints

In assembling threaded line pipe, it is extremely important that the threads be clean and dry before applying thread compound. Any sand or other foreign material in the threads will cut them and may result in improper make-up or failure of the threads. The following procedure is recommended:

a. Immediately before assembly, remove the protectors from both ends and carefully inspect the threads. Those found to be damaged should be laid aside unless there are satisfactory means for correcting the thread damage. Refer to the visual inspection standards of API Spec 15HR for allowable limits.

b. Brush dirty threads with a clean wire brush. This is extremely important on pipe that has been in prior service.

c. Wash dirty threads. Dry threads completely with tissue or rags. Any liquid left in the root of the threads will prevent good thread lubrication.

CAUTION: The manufacturer's directions, precautions and Material Safety Data Sheets for cleaning fluids should be read and observed. Observe appropriate regulations relative to disposal of used cleaning fluids.

d. Cover pin and box threads with thread compound as recommended by the manufacturer.

Note: PTFE (Teflon™) tape is not required to affect a seal with API 8-round threads. Its use may afford an increase in leak tightness when connections are made up without torque control. There will be some increased tendency for thread damage when taped connections are broken out. Use only as specified by the manufacturer.

e. Fiberglass threads may be damaged by over-tightening. Start the threads by hand, making sure the thread is straight. Make up hand-tight, then tighten with a strap wrench or manufacturers supplied wrench. Use powered wrenches with caution. Make up in accord with the manufacturer's recommended practices.

Note: The torque values for make up of fiberglass pipe are significantly lower than torque values required for steel tubulars.

7.2.4 Proprietary Connections

Proprietary connections should be handled and joined according to the manufacturers recommendations.

7.2.5 Fiberglass-to-Steel Connections

When making threaded fiberglass pipe-to-steel connections, inspect the steel threads for burrs that could cut the fiberglass pipe threads. Remove burrs from steel threads by chasing with a threaded steel fitting. The preferred steel-to-fiberglass connection is fiberglass pin in a steel coupling (box).

CAUTION: Fiberglass pipe threads are typically long form. Short form steel threads are often used in linepipe installations. When connecting the long form pin into the short form coupling (box), remove threads from the pin end in accord with Table 1.

7.3 PRESSURE TESTING

7.3.1 Pressure testing is recommended and may be required to insure the line will withstand normal operating pressures. Lines in the ditch must be covered sufficiently to minimize pipe movement. The connections and fittings should be left uncovered for inspection during the testing period.

Pressure testing should be performed using a recording device to monitor/record line pressure as a function of time. A minimum test duration of 4 hours is recommended. During the test hold period, the line should be walked and the pipe/connections visually examined for evidence of leakage, distortion, or other evidence of damage.

CAUTION: Failure of products under pressure can be hazardous to personnel and equipment.

7.3.2 Testing a system for leaks should be done in segments as small as practical. Gases, such as air, should never be used for pressure testing. When water is used, all air should be removed from the lines before the test is started. The water should enter the line at a low point and means provided for bleeding air at high points. Any entrapped air will be compressed during testing and give erroneous results. A successful procedure for accomplishing complete air removal during fill is to force a pig ahead of the water, displacing air while filling the line. Pressure in fiberglass line pipe will not remain constant for extended periods of time where variations in ambient temperature occur. Follow the manufacturer's recommended practices when pressure testing.

Note: Because of environmental considerations, the use of fresh water for hydrotesting may be desirable.

Table 1—Pin End Thread Removal

API External Upset Tubing Size[a]	Threads to cut off to match short form
1.90	6
$2^3/_8$	5
$2^7/_8$	6
$3^1/_2$	6
4	6
$4^1/_2$	7

[a] Dimensions for fiberglass EUE tubing threads are found in API Spec 5B (14th Ed.). Fiberglass EUE thread dimensions are found there in Table 14; and steel EUE thread dimensions are found in Table 13.

API Casing Size[a]	Threads to cut off to match short form
$4^1/_2$ (9.5 lb/ft)	8
$4^1/_2$ (other weights)	3
$5^1/_2$	5
$6^5/_8$	7
7	7
$7^5/^8$	7
$9^5/_8$	11

[a] Dimensions for casing threads are found in API Spec 5B. Long form thread dimensions are found there in Table 7, and short form thread dimensions are found in Table 6.

7.3.3 Air with a maximum pressure of 5 psi may be used for locating leaks. All connections and fittings should be covered with a soap solution to test for leaks after reaching the tes pressure. Leaks found by air test can be quickly repaired since water does not have to be removed from the line or pumped from the ditch. Gas lines should be leak tested. Air and odorizer type leak detectors can be used to improve the test.

7.3.4 If pressure testing is conducted on a complete system rather than on individual segments, the test pressure should be governed by the segment having the lowest rating. Water tests should always be at pressures established by agreement between the installation contractor and the purchaser provided they do not exceed manufacturer's recommendation. Applicable governmental regulations must be considered.

7.4 BACK FILLING

7.4.1 Back-filling should be done as soon as possible after testing to protect the pipe from damage, i.e. that which could be caused by falling boulders, side wall cave in, flooding of the open ditch, and frozen back-fill material. Refer to AWWA Standard C-950, or ASTM D3839, for additional information.

7.4.2 When starting the back-fill, care should be taken to place sufficient back-fill material beneath the pipe to fill all voids between the pipe and the bottom of the ditch. The pipe should be covered with a fine-grained material, such as sand or loose soil, in accord with the manufacturer recommendations. Larger-grained fill can be used as the cover is increased.

7.4.3 Special care should be taken for pipe buried with more than three feet of cover to insure that the pipe is firmly supported by surrounding fill. This support enables the pipe to resist the overburden load of the fill material and in shallower depths, minimizes possible movement of the line which could cause abrasion to the pipe wall.

7.5 SURFACE LINES

7.5.1 Follow the recommendations given under Sections 4, 5, 7 and 8. Anchor and guide the pipe to prevent movement which could cause abrasion or subject the pipe to excessive loading. Support spans for overhead pipe should follow the manufacturer's recommendations. See AWWA C-950 for additional information.

7.5.2 The use of thrust blocks should be considered. Follow the manufacturer's recommendations. See AWWA C-950 for additional information.

8 Repair

8.1 TUBING

a. Tubing body damage is not repairable. Tubing with excessive damage should not be used.

b. Repair of leaking tubing connections should be attempted by breaking out the connection, cleaning, and examining the threads. If the threads are acceptable, thread compound should be applied and the connection made-up and pressure tested. If the connection fails the pressure test, the repair procedure can be repeated, the threads can be reconditioned, or the pipe set aside.

c. If threads are not acceptable, they should be reconditioned in accord with manufacturers recommendations. The acceptability of reconditioned threads should always be confirmed by gaging and inspection, in accordance with the applicable product specification.

8.2 LINE PIPE

a. Low pressure line pipe body leaks are repairable using saddles or by replacement of the damaged section. A written procedure should be followed in making repairs. See Appendix D for repair product guidelines.

b. Leaking bonded joints can be repaired by overwrapping. The use of a written procedure is recommended. See Appendix D for repair procedure guidelines.

c. High pressure line pipe body leaks are not repairable. The damaged section must be removed and replaced. This is accomplished by uncovering the damaged area for approximately one full joint length to either side of the damage. The damaged area, plus two feet in both directions is cut and removed. The pipe ends can be field-threaded, in accord with manufacturer's recommendations, and replaced with a cou-

pling—nipple flange—flange arrangement. Manufacturer's recommendations should be followed closely.

d. Leaking threaded connectors can be repaired by breaking the connection and cleaning the threads, reapplying thread compound and reassembling. It is impractical to break threaded connections in the middle of a pipeline without cutting the pipe and using a repair joint of fiberglass flanged at the cut. Alternately, threaded connections can be replaced by cutting them out of the line and installing a manufacturer-supplied repair joint/pipe section; or by following the manufacturer's field-threading techniques to replace the threads. See Appendix D.

9 Operating Conditions and Considerations

9.1 Changes in operating conditions will affect the design life. If the material conveyed is changed from the original service in terms of increased pressure, temperature, or fluid velocity, or change in chemistry, consult the manufacturer's design literature. It is recommended that the manufacturer's design literature for the product used be incorporated and maintained in the well or job file, at the time of installation, for future reference.

9.2 For cleaning of strings, i.e., acidizing, hot oiling or other technique, refer to the manufacturer's recommended practice.

9.3 The ultraviolet (UV) component of sunlight will degrade the resins used in the production of fiberglass tubulars (during storage).

a. *Tubular body.* On the body, the degradation due to ultraviolet light exposure is insufficient to affect product service life.

b. *Threaded connections.* Significant damage can result due to prolonged exposure. Damage to threaded areas is indicated by whitened and/or powdery surfaces. Consult the manufacturer before installation of tubulars with ultraviolet thread degradation. Fiberglass tubing should always be stored with thread protectors in place to avoid degradation.

c. *Bonding surfaces.* Significant damage, including loss of bond strength, can result due to prolonged exposure of the bonding surface to ultraviolet light. Damage is indicated by whitened and/or powdery surfaces. Consult the manufacturer before assembling pipe with ultraviolet bond surface degradation. Fiberglass pipe should always be stored with protectors in place to avoid degradation.

APPENDIX A—GUIDELINES FOR PREPARATION OF A WRITTEN ADHESIVE BONDING PROCEDURE

A.1 Scope

The scope of applicability of the procedure should be stated in terms of pipe site, pressure class, application and piping products.

A.2 References

Reference specifications and standards should be cited.

A.3 Bonding Procedure

The procedure specific requirements are cited. These should include consideration of the following:

A.3.1 ENVIRONMENT

The environmental conditions under which the bonding is permitted to take place should be clearly stated. Usual provisions include:

a. Pipe surface temperature permissible during bonding: A range of 70° to 100°F is often specified with heating or cooling provisions included.
b. Humidity/moisture limits during bonding should be stated. Bond is not recommended on wetted surfaces.
c. Cleanliness levels. Blowing sand and dust usually require some form of protection during bonding as sand/dust in bond joints is detrimental.

A.3.2 STRINGING AND BLOCKING

A description of how the pipe is to be strung and blocked (supported) for assembly.

A.3.2.1 A description of stringing instructions. Generally, where the pipe is to be strung and handled.

A.3.2.2 A description of how the pipe is to be blocked. Normally given in general terms with some minimum height above ground surface required.

A.3.3 SURFACE PREPARATION

A description of joint protection prior to bonding and preparation for bonding.

A.3.3.1 Joint protection. Usual requirement is for end caps/protectors to remain in place until just prior to cleaning/bonding.

A.3.3.2 Joint examination. The joint is normally visually checked for cleanliness/damage and UV degradation. UV degradation is detected by sanding and looking for color change. Refinishing by sanding and/or retapering is often required if UV degradation is detected or if the joint has been exposed for a limited period of time (often specified as 0.5 to 1.0 hours).

A.3.3.3 Tapering instructions should be provided. Reference should be made to specific tools, sand papers and grits if necessary. Cleaning is always required after sanding or retapering. After tapering, the match up/fit of the joint should be verified. When assembled dry, without adhesive mixture, there should be no looseness.

A.3.4 JOINT CLEANING

A detailed description of the joint cleaning procedure, including the materials to be used.

A.3.4.1 Joint cleaner and wiping materials should be specified in detail. Materials are not normally reused.

A.3.4.2 Cleanliness level. The procedure should require all oil, grease, mud and fingerprints to be removed. Once cleaned the joint should not be touched.

CAUTION: Solvents are normally volatiles and may build up pressure in containers. A general understanding of the health and safety conditions as stated on the Material Safety Data Sheets is generally required. Storage, transport, use, and disposal of excess materials and containers should be considered.

A.3.5 ADHESIVES

Detailed instructions for mixing of the adhesives are required.

A.3.5.1 Mixing. Complete mixing instructions should be provided. The instructions should consider the effects of temperature, splitting a kit and determination that mixing is complete. Normal requirements are for adhesive to be in the 60° to 80°F range at time of mixing, no splitting of adhesive kits, and uniform color/consistency.

A.3.5.2 Shelf life. Information relative to the working life of the mixed adhesive is required. The working life is normally specified in terms of time at a specified ambient temperature. Shelf life varies directly with temperature. Instructions often include suggestions for keeping the mix cool, such as, wrapping with wetted rags, or storing in the bottom portion of a cardboard box lined with wetted rags/paper towels.

CAUTION: The hardener contained in the adhesive kits might burn the skin. Inhaling the vapors should be avoided. The manufacturers precautions, and Material Safety Data Sheets should be read and observed. Store and dispose of the container, mixing tools, and unused materials in accord with appropriate regulations.

A.3.6 JOINT ASSEMBLY

Detailed instructions should be provided for the application of the adhesive and alignment/mating of the joints. This portion of the procedure will depend on the type of joints being bonded and should consider bonding to flanges and fittings.

A.3.6.1 Alignment. Joints must be axially aligned. Visually detectable misalignment is normally unacceptable.

A.3.6.2 Warming. Bonding surfaces should be heated or cooled to bring to the appropriate bonding temperature. Bonding surfaces should never be touched by fingers or tools after cleaning.

A.3.6.3 Adhesive application. Specific instructions relative to application of the mixed adhesive is required. Instructions normally require brush application of a thin uniform coat (3 to 10 mils) on both surfaces. Excess adhesive may interfere with obtaining a locked position on tapered joints. Apply adhesive to the bell first to reduce potential for contamination.

A.3.6.4 Alignment and locking of the joint. Instruction on how the bell and spigot are to be engaged. The instructions will vary depending on the type of joint being used. For a tapered bell and spigot joint, the instructions will normally include the use of rubber mallets on small diameter pipe (< 8 in.) and hydraulic come-alongs on larger diameter pipe (> 8 in.). If a hydraulic come-along is used, the pressure required to obtain lock-up is specified along with a maximum pressure loss if the joint is vibrated or tapped with the mallet (to indicate proper lock-up).

A.3.7 HEAT ASSISTED CURING

Requirements for, and acceptable methods of, assisting the joint cure through addition of external heat should be considered.

A.3.7.1 The requirement. A statement is needed to define when heat assistance is required.

A.3.7.2 The method. A statement describing the method to be used to provide the external heat is required. Specific equipment identification is normally provided.

A.4 Examination/Documentation

Each bonded joint should be visually examined and documented if required. A suggested inspection sheet is provided as Appendix C.

A.5 Procedure/Personnel Qualification

Written procedures, and bonding personnel, should be qualified prior to field use. Appendix B provides an outline for personnel qualification.

APPENDIX B—GUIDELINES FOR PREPARATION OF A WRITTEN PIPE BONDER QUALIFICATION PROCEDURE

B.1 Scope

The applicability of the qualification tests should be stated in terms of pipe size, pressure class, and joints.

B.2 References

Applicable reference practices, standards, and commercial literature should be clearly identified.

B.3 Instruction

All personnel on installation crews should be provided with instruction on the bonding procedure and joints to be bonded.

B.3.1 INSTRUCTION REQUIREMENTS

Instruction requirements should be stated in terms of who is to instruct and what information is to be covered.

B.3.2 EXAMINATION

Pipe bonders are required to pass a written examination prior to proceeding with qualification.

B.3.3 QUALIFICATION TEST BOND

Each bonder to be qualified should be required to bond a sample connection using the written procedure, and have passed the written examination.

B.3.3.1 Qualification sample. The specimen on which qualification testing is to be performed should be identified in terms of size, pressure rating and joint type. Normally, the bonder works with his crew, and the largest pipe covered by the procedure is bonded.

B.3.3.2 Grading of sample joint. The qualifying agency representative will observe the fabrication of the bonded joint and grade the bonder on his knowledge and application of the procedure.

B.4 Sample Evaluation

The method of testing the sample should be clearly defined. Normally, a short-term pressure-to-failure test in accordance with ASTM D1599 is specified. Loading should be in both the axial and circumferential directions. Acceptance criteria should be specified.

B.5 Qualification

Only persons who pass the written examination, who demonstrate a practical knowledge of the procedure and method and whose test sample passes the criteria of B.4 should be qualified to bond in accordance with the written procedure.

APPENDIX C—SAMPLE JOINT INSPECTION CHECKLIST

Inspector: _____ Joint Number: _____
Bonder I.D.: _____ Date and Time: _____

1. Environmental
   Ambient Temperature: _____°F
   Moisture Conditions: _____
   Wind Conditions (Sand/Dust): _____
2. Ground Clearance (16" minimum): _____inches
3. Are end protectors in place? (30 minutes maximum between removal and joint makeup.)
   Spigot: Yes No
   Bell: Yes No

Comments:
_____
_____

4. Ultraviolet Degradation Check:
   Did spigot show degradation? Yes No
   Did bell show degradation? Yes No
   Action Taken:
   Spigot retapered (witness and verify taper) _____(Initial)
   Bell sanded (witness and check bell) _____(Initial)
   Pipe replaced (mark pipe with paint) _____(Initial)

Comments:
_____
_____

5. Joint Cleaning:
   Inspected surface for oil, dirt, etc. Yes No
   Insured clean towels from kits are used. Yes No
6. Adhesive Mixing:
   Adhesive Temperature: _____°F
   Was all hardener used? Yes No
   Was adhesive thoroughly mixed? Yes No
7. Visual inspection of joint alignment. Done Not Done
8. Bonding surface temperature (70° to 120°F). _____°F
9. Was adhesive applied correctly? Yes No
10. Hydraulic come-along. Delta P (1st Blow) ____psi
    Final Pressure ____psi
    Are hydraulic cylinders bottomed out? Yes No
11. Heat Collars:
    Time on: _____
    Time off: _____
    Temperature: _____°F

APPENDIX D—GUIDELINES FOR PREPARATION OF A WRITTEN REPAIR PROCEDURE

D.1 Scope

The scope of applicability of the procedure should be stated in terms of pipe size, pressure class, application, and piping products. The scope should also describe acceptable repair methods.

D.2 References

Reference specifications and standards, including applicable procedures, should be cited.

D.3 Line Pipe Body Repairs

Note: The following provide some examples of commonly used repair methods. It is not an endorsement of these techniques for all applications. The user should determine what is appropriate for application.

D.3.1 PIPE SADDLE REPAIR

D.3.1.1 The patch. A length of good pipe is cut and slit longitudinally to remove a segment to form a saddle patch. The size of the segment to be removed (often 120° of circumference) and length of the patch should be specified. The size of the damage to be repaired using this method should also be specified (for 2-in. and larger pipe, a maximum damaged surface area with a 2.0-in. diameter is often specified).

D.3.1.2 Preparation. The patch and damaged pipe area are sanded to remove all gloss in preparation for bonding. The length of the area to be sanded, and sand paper, including grit, should be specified. At a minimum of 1 inch past each end of the patch, 40 and smaller grit sandpaper is often specified.

D.3.1.3 Cleaning. The sanding areas require thorough cleaning to remove all foreign material, oils, greases and fingerprints. The cleaning agent (solvent) and wiping materials are normally specified.

D.3.1.4 Bonding. A heavy coating of mixed adhesive is applied to both surfaces and the patch is snapped into place. During curing the patch is held in place with a hose clamp at each end of the patch. The adhesive is normally specified along with mixing and curing requirements and when (or if) the clamps should be removed. See Appendix A for sample mixing instructions.

D.3.2 SLEEVE COUPLING REPAIR

For damaged areas greater than that permitted to be repaired by saddle patches, a sleeve coupling repair is often used.

D.3.2.1 The damaged area of the pipe is cut out using an appropriate tool. Care is required to insure that the entire damage is removed. A maximum damage area is normally specified, often in the 2- to 4-inch range. A hacksaw with a 22 to 26 (teeth per inch) blade is often used.

D.3.2.2 Preparation. The cut ends of the pipe must be prepared for bonding by tapering and/or sanding. The type of preparation, tools, and the sanding materials required are normally specified.

D.3.2.3 Cleaning. The sanding areas require thorough cleaning to remove all foreign material, oils, greases, and fingerprints. The cleaning agent (solvent) and wiping materials are normally specified.

D.3.2.4 Bonding. The procedure should specify the adhesive and mixing instructions. See Appendix A.

D.3.2.5 A coupling, with appropriate joints at each end, is inserted and bonded in place in the gap. The acceptable joint type, method of preparation for the cut pipe ends, and bonding procedure are normally required to be specified. See Appendix A.

D.3.3 PIPE SECTION REPLACEMENT AND REPAIR

For damage greater than that permitted to be repaired by saddle patches, a sleeve coupling repair is often used.

D.3.3.1 The damaged area of the pipe is cut out using an appropriate tool. Care is required to insure that the entire damage is removed. A maximum damage area is normally specified.

D.3.3.2 Preparation. The cut ends of the pipe must be prepared for bonding by tapering, or sanding, or as required. The type of preparation, tools, and sanding materials required should be specified.

D.3.3.3 Cleanliness level. The procedure should require all oil, grease, mud, and fingerprints to be removed. Once cleaned, the joint should not be touched.

D.3.3.4 Couplings, and a replacement pipe section with appropriate joints at each end, are inserted and bonded in place in the gap. The acceptable joint type, method of preparation of the cut pipe ends, method of establishing the replacement pipe length, and bonding procedure are normally required to be specified. See Appendix A.

D.4 Leaking Joint Repair—Overwrap Procedure

Leaking bonded joints can be repaired by the method of D.3.3, or by overwrapping with glass cloth and resin by following the manufacturer's recommended procedures.

CAUTION: Manufacturer's overwrap procedures should, at a minimum, include information relative to the design of the overwrap procedures for overwrapping, qualification of the overwrap procedure, and adequate proof that new pipe performance ratings are maintained when the overwrap procedure is followed.

D.4.1 PREPARATION

The leaking joint should be uncovered (excavated) and prepared for overwrapping. The paragraph should describe the amount of space required for the overwrapping procedure.

D.4.2 COLLAR (BELL) PREPARATION — BEVELING

The collar or bell should be beveled by grinding or sanding to form a smooth sloped transition to the pipe body. The equipment and sand paper to be used, including the grit range, should be specified.

D.4.3 CLEANING

The sanded areas require thorough cleaning to remove all foreign material, oils, greases, and fingerprints. The cleaning agent (solvent) and wiping materials are normally specified. See Appendix A.

D.4.4 OVERWRAPPING

The procedure should specify the adhesive and mixing instructions and the glass cloth to be used. The procedure should include specific instruction on how to overlap the cloth and the number of layers that are required. See Appendix A.

APPENDIX E—TUBING MANUFACTURER'S INSPECTION TECHNIQUES AND CRITERIA

E.1 Introduction

The following paragraphs describe inspection techniques used by manufacturers of fiberglass tubing. This information is provided for guidance. Table E-1 provides a definition of various defects and acceptance criteria useful in visual evaluation of new fiberglass tubing.

E.2 Mill Test Methods

The following test methods are likely to be required by the API fiberglass tubing specification when it becomes effective.

E.2.1 MILL TESTS PERFORMED ON EACH JOINT OF TUBING

a. *Hydrostatic mill test.* Each length of tubing receives a combined tension (150% maximum standard rating) and internal pressure (150% of allowable internal pressure) test for 2 minutes.
b. *Visual inspection.* Each joint is inspected in accordance with the criteria of Table E-1.
c. *Wall thickness.* The wall thickness is measured by mechanical or magnetic caliper at least 6 in. from upsets at approximately 90° increments on tube body. The measured values should not be less than the manufacturer's published minimum value.

E.2.2 MILL TESTS PERFORMED ONCE PER LOT (5,000 FEET OR PORTION THEREOF)

a. *Short-time axial failure*. A test specimen consisting of a connection with a minimum of five diameters of tubing on either side is tested in accord with ASTM D2105, except the failure is to be induced within 60 to 70 seconds of loading.
b. *Short-time pressure failure*. A specimen, as in E.2.3, is tested to failure in accord with ASTM D1599 at ambient temperature. Failure should not be less than 85% of manufacturer's published value.
c. *Glass content*. The weight of glass per unit of length of tubing body is determined in accordance with ASTM D2584. The weight determined should be within 5% of manufacturer's published specification.

E.2.3 MILL TEST FOR DEGREE OF CURE

Demonstration of degree of cure through use of glass transition temperature monitoring. Monitoring should be accomplished with a differential scanning calorimeter once each winding shift.

E.2.4 MILL THREAD GAGING

Manufacturers typically gage threads in accordance with API RP 5B1 at the following frequency:

a. *Machined threads.* Every 25th joint should be gaged (both pin and box threads).
b. *Molded threads*. First article from each impression mandrel and every 100th part from the mandrel should be gaged.

Table E-1—Recommended Visual Standards

Defect	Description	Recommended Maximum Size
	Tube Body and Coupling	
Burn	Thermal decomposition evidenced by distortion or discoloration of the surface.	20% area—lightly blemished, 5% area—distortion or discoloration of the surface. Moderate burn of outer resin layer structural roving.
Chip	Small piece broken from edge or surface.	Permitted if laminate has not been fractured.
Crazing	Fine cracks at or under the surface as seen by the unaided eye.	None permitted.
Cut Roving	Broken or cut outer rovings due to scraping, scuffing, or manufacturing process.	Maximum 3 per pipe with 1 $in.^2$ maximum size such that the wall thickness is not reduced below minimum.
Dry Spot	Area where reinforcement was not thoroughly wet with resin.	None permitted.
Fracture	Rupture of laminate without complete penetration. Visible as lighter colored area of interlaminar separation.	None permitted.
Pits (pinholes)	Small craters in the surface.	Maximum $^1/_{16}$" deep, no limit on number.
Resin Drip	Resin protrusion.	Maximum $^1/_8$" high, no limit on number.
Restriction	Any restriction: paste, epoxy or wax, lump, foreign matter in I.D. of pipe.	None permitted.
Scratch	Shallow mark caused by improper handling.	No limit on number if reinforcement is not exposed; if reinforcement is exposed, see Cut Roving.
Inclusions	Foreign matter wound into laminate.	None permitted.
	Threads	
Air Bubbles	Small bubbles at crest of threads.	Maximum size $^1/_8$", one permitted. Maximum size $^1/_{16}$", 10 permitted.
Broken Thread	Light patch at the root of the thread.	Maximum size $^1/_8$" in any direction and one allowed per pin.
Chips	Areas where over 10% of thread height is removed.	Maximum $^3/_8$" long in one thread per connection, none permitted in L_c area.
Cracks	In direction of thread axis.	None permitted.
Flat Thread	Area where top of thread is broken or ground off.	Maximum $^3/_8$" long in one thread per connection not to exceed 10% of the thread height, none permitted in L_c area.
Squareness	Angle perpendicular to pipe axis.	Maximum $^1/_{16}$" variation in end.
Finish	Finish cut end.	No sharp edges, no exposed loose fiber, no protrusions, no impact areas.

APPENDIX F—METRIC CONVERSION

U.S. Customary units are in all cases preferential and are the standard in this document.

Length

1 inch (in.) = 25.4 millimeters (mm) exactly

Pressure

1 pound per square inch (psi) = 0.06894757 Bar

Note: 1 Bar = 100 kilopascals (kPa)

Strength or Stress

1 pound per square inch (psi) = 0.006894757 Megapascals (MPa)

Impact Energy

1 foot-pound (ft-lb) = 1.3558181 Joules (J)

Torque

1 foot-pound (ft-lb) = 1.3558181 newton-metres (N-m)

Temperature

The following formula was used to convert degrees Fahrenheit (ºF) to degrees Celsius (ºC):

$$ºC = 5/9 (°F-32)$$

Mass

1 pound (lb) = 0.4535924 kilograms (kg)

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