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Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping —

Part 4: Fabrication, installation and operation

Industries du pétrole et du gaz naturel — Canalisations en plastique renforcé de verre (PRV) —
Partie 4: Construction, installation et mise en œuvre

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

This second edition cancels and replaces the first edition (ISO 14692-4:2002), which has been technically revised. It also incorporates the Technical Corrigendum ISO 14692-4:2002/Cor 1:2006.

A list of all parts of ISO 14692 can be found on the ISO website.

Introduction

The objective of this document is to ensure that installed GRP piping systems will meet the specified performance requirements throughout their service life. Main users of the document are envisaged to be the principal, fabrication/installation contractors, repair and maintenance contractors, certifying authorities and government agencies.

Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping —

Part 4: Fabrication, installation and operation

1 Scope

This document gives requirements and recommendations for the fabrication, installation, inspection and maintenance of GRP piping systems for use in oil and natural gas industry processing and utility service applications. The recommendations apply to delivery, inspection, handling, storage, installation, system pressure testing, maintenance and repair.

It is intended to be read in conjunction with ISO 14692-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 14692-1, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 1: Vocabulary, symbols, applications and materials*

ISO 14692-2:2017, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 2: Qualification and manufacture*

ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings*

ASTM D2583, *Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor*

API Spec 5B, 2008, *Specification for Threading, Gauging and Thread inspection of Casing, Tubing, and Line Pipe Threads*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 14692-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Fabrication and installation

4.1 Delivery, inspection and documentation of GRP piping

The quantity, MSP, nominal dimensions and relevant special requirements of all piping components and prefabricated spools shall be verified for compliance with the purchase order. Shipments of piping components that do not comply with the purchase order shall be reported to the responsible personnel and to the pipe producer for corrective actions.

All piping components shall be visually inspected in accordance with Table A.1 for damage that can have occurred during storage and shipment. Rejected components shall be replaced. If doubts concerning the extent of defects occur during inspection, a specialist approved by the principal shall perform a second inspection of the delivered items.

Adhesive bonding kits shall be inspected to ensure that the kits:

— contain all necessary materials;

— are not leaking or visibly damaged; and

— have at least six months remaining lifetime before the expiration of shelf-life.

All fire protection material shall be inspected to ensure that the original packaging is not damaged.

4.2 Handling and storage

The handling of the GRP components shall follow the requirements given in Annex B and the requirements of the pipe manufacturer.

4.3 System design documentation

The principal shall provide the installer at least with the following information:

a) operating and design parameters:

   1) design pressure;

   2) design temperature (maximum and minimum);

   3) T_g of the resin used in component manufacture;

   4) T_g of the adhesive used in component manufacture, if appropriate;

   5) MSP of each component and MSOP of each piping system;

   6) mean and maximum velocity conditions in each piping system;

   7) chemical resistance limitations, if applicable;

   8) procedures to eliminate or control water hammer and cavitation, if applicable;

   9) fire classification and location of fire-rated pipe, if applicable;

   10) conductivity classification, location of conductive pipe, earth linkage/grounding requirements and location of earthing points;

   11) criticality rating;

b) system drawings and support requirements for heavy equipment;

c) preferred locations for connection of final joint in pipe loops, if appropriate;

d) system criticality and minimum requirements for inspection during installation.

4.4 Installer requirements

4.4.1 Personnel qualification

All pipe, fittings and related items shall be installed by qualified GRP pipe fitters, bonders or spool-builders and thereafter approved by a qualified GRP piping inspector. GRP pipe fitters and GRP piping inspectors shall be qualified according to the minimum requirements detailed in Annex C.

4.4.2 Health and safety

In general, all safety precautions set forth by the manufacturer of pipes and fittings, chemicals, etc. shall be adopted. Materials safety data sheets should always be read before commencing work.

4.5 Installation

4.5.1 General requirements

All piping components shall be installed so that they are ideally stress-free and at least not over-stressed, meaning that:

a) bending of pipes to achieve changes in direction, or forcing misaligned flanges together by over-torquing bolts is not permitted;

b) the manufacturer's recommendations for bolt-torquing sequence, torque increments and maximum bolt torque shall be followed;

c) all supports shall be installed (location and function) as per system design.

Prefabricated pipework shall be fabricated in accordance with fully dimensioned piping isometrics. Overall spool dimensions shall be sized, taking the following into consideration:

— site transport and handling equipment limitations;

— installation and erection limitations;

— limitations caused by the necessity to allow a fitting tolerance for installation ("cut-to-fit" requirements).

If shown on isometric drawings, the fabrication shall include "cut-to-fit" lengths and field joints on fabricated pieces to allow for the setting up of pipework accurately on-site between fixed points. "Cut-to-fit" lengths shall be left square and plain.

The installer shall take the following considerations into account.

a) The need to avoid overstressing of GRP components by the forced pulling of GRP pipework to facilitate alignment at joints, and particularly at flanged joints.

b) The need to prevent damage to joints when handling small-diameter thick-walled pipe, e.g. due to fire protection.

NOTE This is because the high rigidity of the pipe concentrates loading at the thinner sections of pipe wall adjacent to the joint.

c) The preferred location of the last site joint in a piping loop to ensure that necessary access is available, since this joint is often the most difficult to complete.

d) Delays caused by the time required for adhesive or laminated joints to cure without being disturbed. The scheduling of surrounding construction activities shall take into account the risk of possible disturbances to such joints.

e) The need to provide temporary protection for installed GRP piping if risk of mechanical damage is high. The installer shall also consider correct sequencing of fabrication activities to minimize risk of damage.

f) The need to prevent overheating of the GRP pipe material by electric surface heating, if applied. Heat tracing should be loosely spirally wound onto GRP pipe in order to distribute the heat evenly around the pipe wall. Heat distribution can be improved if aluminium foil is first wrapped around the pipe.

g) Provision of suitable joints to facilitate isolation or access to the pipe for maintenance purposes.

4.5.2 Components fabricated on-site

All processes used to fabricate spoolpieces and components on-site, e.g. mitred elbows, tee pieces and laterals, shall have been qualified according to procedures given in ISO 14692-2:2017, Clause 5.

4.5.3 Cutting

GRP pipe shall be cut according to the manufacturer's instructions.

For adhesive-bonded connections, the pipe end shall be machined with a pipe shaver according to the manufacturer's recommendations.

4.5.4 Above ground application — Supports

GRP piping systems may be supported using the same principles as those for metallic piping systems. However, due to the proprietary nature of piping systems, standard-size supports do not necessarily match the pipe outside diameters. The use of saddles and elastomeric (neoprene) pads may allow the use of standard-size supports.

The following guidelines to GRP piping support shall be followed.

a) Supports in all cases should have sufficient width to support the piping without causing damage and should be lined with an elastomer or other suitable soft material.

b) Clamping forces, if applied, should be such that crushing of the pipe does not occur. Local crushing can result from a poor fit and all-round crushing can result from over-tightening.

c) In all cases, support design should be in accordance with the manufacturer's guidelines.

d) Supports should preferably be located on plain pipe sections rather than at fittings or joints.

e) Supports shall be spaced to avoid sag (excessive displacement over time) and/or excessive vibration for the design life of the piping system.

f) Valves or other heavy attached equipment shall be adequately and if necessary (as determined from system design calculations) independently supported.

g) GRP pipe shall not be used to support other piping, unless agreed with the principal.

h) Consideration shall be given to the support conditions of fire-protected GRP piping. Supports placed on the outside of fire protection can result in loads irregularly transmitted through the coating, which can result in shear/crushing damage and consequent loss of support integrity.

i) GRP piping should be adequately supported to ensure that the attachment of hoses at locations such as utility or loading stations does not result in the pipe being pulled in a manner that could overstress the material.

j) The anchor or linestop support shall be capable of transferring the required axial loads to the supporting structure without causing overstress of the GRP pipe material.

k) Anchor or linestop clamps are recommended to be placed between two double 180° saddles, adhesive-bonded or laminated to the outer surface of the pipe. The manufacturer's standard saddles are recommended and shall be bonded using standard procedures.

4.5.5 Buried piping

The following guidelines to buried piping shall be followed.

a) In-situ conditions — an appreciation of the local soil conditions and water table should be obtained prior to trench excavation.

b) Embedment materials — the local soil type should be identified in order to determine the support that can be provided to the buried GRP pipe system. Other issues to consider include moisture content and permeability which, if inappropriately selected, could lead to improper settlement.

c) Considerations for use of soil in backfill — the soil properties should be assessed in terms of potential compaction. A too large compaction load can damage the GRP pipe.

d) Trench excavation — the trench sides should be stable under all working conditions. Excavated soil material should not be placed near the edge of the trench. Ideally, water should be removed from the trench prior to pipe laying and backfilling.

e) The minimum width of the bottom of the trench for a single pipe should be a least 1,5 times the pipe diameter. For multiple pipes, the distance between pipes should be at least 0,5 times the larger pipe diameter and the gap between the outer pipe and the trench wall should be at least the same width as for a single pipe.

f) Trench bottom — all rock, hard pan and sharp objects shall be removed.

g) Preparation of the trench — the bedding material on the trench bottom should be a least 100 mm thick and provide the correct gradation and pipe support. All localized loading should be minimized, e.g. through the presence of other subsurface structures by providing at least a 300 mm bedding or compacted backfill layer.

h) Placing and joining pipe — the GRP pipe shall be placed in the trench, such that it is uniformly supported. Extra backfill or bedding material should not be added or extra backfill should not be forced in to provide this support. All joints should be installed according to the manufacturer's installation guideline.

i) Placing and compacting backfill materials — backfill materials should be placed around the GRP pipe, such that they will not disturb or damage the pipe. The backfill material should be worked into the underside of the pipe before backfilling the trench.

j) Compacting the backfill material — the backfill material should be compacted in the trench but it should be ensured that the compacting loads will not damage the buried pipe. The minimum cover of backfill material should be such that no damage to the buried pipe is caused by surface loads, e.g. vehicle weight. . Design guidance on burial depth is provided in section 5.7.3 of AWWA Manual M45 (second edition).

k) Thrust blocks, if required, shall be capable of transferring the axial loads to the supporting structure without causing overstress of the GRP pipe system.

Further guidance on GRP buried pipe installation is provided in Clause 6 of AWWA M45:2013 (second edition) and design of thrust blocks in Clause 7 of AWWA M45:2013.

4.5.6 Tolerances

Global tolerances shall be within ±6 mm in all directions, unless otherwise shown on the approved drawings. Dimensional tolerances for finished piping are given in Table 1. The dimension numbers are shown in Figure 1.

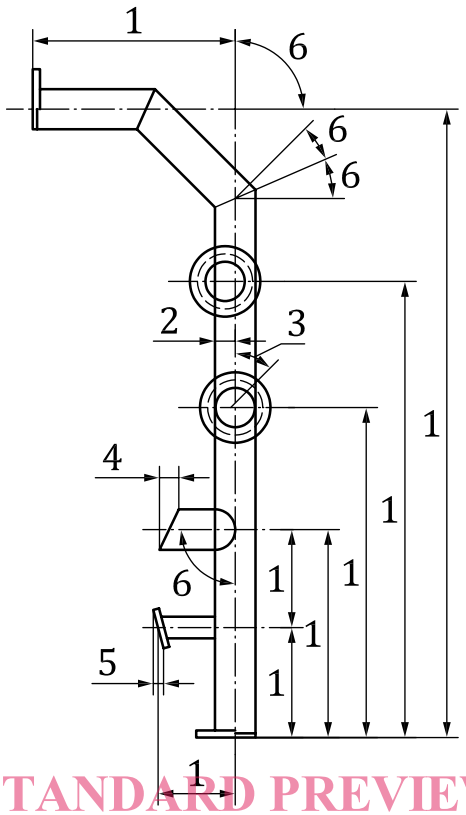
The acceptable tolerances for misalignment of flanges during installation are given in Table 2. It is common practice for some flanges to be manufactured with bolt holes larger than the size of bolt being used with the flange. Typically, the hole will be 3 mm larger. This should be taken into account when assessing the flange misalignment tolerance in Tables 1 and 2.

Table 1 — Maximum dimensional tolerances

Internal pipe diameter	Tolerances (relative) Dimension number (see Figure 1)					
	1	2	3	4	5	6
mm	mm	mm	° (degrees)	mm	mm	° (degrees)
25 to 200	±5	±3	±0,5	±3	±1	±0,5
250 to 300	±5	±3	±0,4	±3	±1	±0,5
350 to 400	±5	±3	±0,3	±3	±2	±0,5
450 to 600	±10	±5	±0,3	±3	±2	±0,5
700 to 900	±10	±5	±0,2	±5	±3	±0,5
1,000 to 1,200	±10	±5	±0,15	±6	±3	±0,5
1,200 to 4,000	±15	±10	±0,15	±10	±5	±1
The maximum gap shall be limited to 6 mm.						

Table 2 — Acceptable tolerances for misalignment of flanges during installation

Misalignment	Tolerances		
	Diameter range		
	50 mm to 300 mm	300 mm to 1 200 mm	1 200 mm to 4 000 mm
Flange misalignment (mm)	±1,6	±3,2	±5
Separation between spools (mm)	±2	±5	±10



Key

1 face-to-face dimensions, or centre-to-face dimensions, or location of attachments, or centre-to-centre dimensions

2 lateral translation of branches or connections

3 rotation of flanges, from the indicated position

4 end preparations

5 cut of alignment of flanges from the indicated position, measured across the full gasket face

6 angular deflection

Figure 1 — Tolerance dimensions

4.5.7 Jointing

4.5.7.1 General requirements

All jointing shall be performed in accordance with the manufacturer's recommendations. The selection of joint type shall take into account the following:

a) the ease of access required by fitters to assemble the connection correctly;

b) the need to accommodate possible minor misalignments.

If adhesive joints are used, the installer shall ensure that the adhesive bead, which is created when the joint is made up, does not protrude significantly into the bore of the pipe. Such a protrusion can create a substantial blockage factor, as well as a source for erosion and cavitation damage. The height of adhesive bead shall be such that the maximum flow obstruction is 5 % of the inner diameter or 10 mm, whichever is smaller.

Guidance on joint type and assembly is given in Annex D.

4.5.7.2 Quality control of adhesive and laminated joints

If so required by the principal, the following requirements shall be included for installation.

a) The frequency of hydrotesting shall be agreed between the installer and the principal.

b) The adhesive or resin used shall be in accordance with the manufacturer's recommendation and its degree of cure shall be determined according to the requirements given in ISO 14692-2:2017, Table 3.

c) The laminate surface shall be a minimum of 3 °C above the dewpoint.

The glass transition temperature, T_g, of the cured adhesive or resin shall not be less than 95 % of the minimum value quoted by the manufacturer. This quoted value shall be demonstrated as an acceptable criterion from the qualification test results.

For polyester and vinyl ester resins, the residual styrene monomer content may be determined by measuring on a dummy joint made up prior to starting the jointing work. The styrene content shall be less than or equal to 2 % (mass fraction) of the resin content.

The Barcol hardness shall be measured on all laminated joints using GRV or GRUP. The number of readings shall be determined from ASTM D2583. The minimum number of readings shall be ten. The two highest and two lowest readings may be discarded, with the remaining six to be used to calculate an average reading that shall not be less than 90 % of the minimum value quoted by the manufacturer.

For small diameter pipework, the outside curvature of the pipe can make it awkward to measure consistent readings. Care is required, therefore, when measuring Barcol hardness on small diameter pipework.

4.5.8 Application of fire-protective coating

The coating should preferably be applied after hydrotesting, to facilitate inspection of possible leaks.

The application of fire-protective materials to meet requirements concerning either flame spread, smoke or toxicity shall be integral to the pipe construction. On-site application of such material shall be limited to that required for installation purposes, e.g. field joints.

If a fire-protective coating is used for the sole purpose of meeting the fire endurance requirements, the coating shall preferably be applied by the pipe manufacturer, or an approved company, at the pipe manufacturer's location or approved company's location. The pipes may be coated on-site in accordance with the approved procedure, subject to on-site inspection and verification.

All fire protection applied to piping components shall be subjected to the following requirements.

a) The contractor, if used, for fire-protection application shall have a quality management system and shall, in addition, have written application procedures, covering environmental control, application and inspection aspects, which are approved by the principal.

b) The following methods are acceptable for applying or covering piping components with fire protection:

   1) conventional hand application;

   2) automated process;

   3) use of moulded half-shells or sections of different shapes and lengths.

c) Before initiating fire-protection work on piping components, the contractor's personnel intending to apply the fire insulation material shall

   1) have received training both in the application method and actual application of the fire-protection materials under the instruction of the fire-protection manufacturer,

2) have applied fire protection to a sample pipe and fitting that is approved by the fire-insulation manufacturer and by the principal.

The contractor shall use application equipment recommended by the fire-protection manufacturer. Before fire-protection material is applied to any piping components, the surfaces shall be free from moisture, grease or any other contaminants.

After the fire-protection material is applied to the piping components, an inspection of the fire protection shall be carried out to approve or reject the work. Inspection shall include the following aspects:

— the fire-protection thickness shall be randomly measured in the cured state; the thickness shall not be less than the minimum required thickness;

— both the finish and the appearance of the fire protection shall be of the same quality as the sample submitted for approval by the fire-insulation manufacturer and the principal.

In fire-protection applications where the protection is to be removable for inspection purposes, e.g. valves and flanges, one of the following situations shall apply:

a) the fire protection shall be inside or outside a box or container so as to provide structural integrity; or

b) a complete structural reinforcing mesh integrated in the fire-protection material shall be used.

4.5.9 Electrical conductivity and electrostatic dissipative properties

If electrical conductivity requirements are specified, the installer shall verify the electrical conductivity and/or earth linkage of the piping is installed according to the requirements documented by the system designer. Further requirements are given in Annex E.

4.5.10 Earthing

If an electrostatic hazard is reported in the documentation provided by the system designer, the contents of the pipes shall be directly connected to earth by at least one exposed earthing point on the inside of the system.

The location and/or maximum distance between earthing points shall be determined from the documentation provided by the system designer.

4.5.11 Quality programme for installation

The contractor shall maintain a high level of inspection and quality assurance to ensure compliance with all requirements of this document, and shall have a quality management system.

The contractor shall designate one individual, experienced in all aspects of GRP piping field fabrication, to be responsible for quality control throughout the installation of the GRP piping system.

Quality control shall be based on the implementation of:

a) records of adhesive and lamination jointing procedure qualification;

b) requirements by the principal for inspection of all types of joints used;

c) inspection register for all types of joints used;

d) inspection of finished fabricated pipework for compliance with design drawings, within tolerances as detailed in 4.5.6.

For quality assurance and quality control during the installation phase, the principal shall have the right to inspect the ongoing work, as well as inspect the contractor's quality control routines.