INTERNATIONAL STANDARD

ISO 14692-4

First edition
2002-12-15

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

Reference number
ISO 14692-4:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 14692-4 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*.

ISO 14692 consists of the following parts, under the general title *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping*:

— *Part 1: Vocabulary, symbols, applications and materials*

— *Part 2: Qualification and manufacture*

— *Part 3: System design*

— *Part 4: Fabrication, installation and operation*

Introduction

The objective of this part of ISO 14692-4 is to ensure that installed piping systems will meet the specified performance requirements throughout their operational 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 part of ISO 14692 gives requirements and recommendations for the fabrication, installation and operation 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, repair and decommissioning.

It is intended to be read in conjunction with ISO 14692-1, which includes an explanation of the pressure terminology used in this part of ISO 14692.

2 Normative references

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

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

ISO 14692-1:2002, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 1: Vocabulary, symbols, applications and materials*

ISO 14692-2:2002, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 2: Qualification and manufacture*

ISO 14692-3:2002, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 3: System design*

API Spec 5B, 1996, *Gauging and inspection of casing, tubing, and line pipe threads*

ASTM D257, *Standard test methods for DC resistance or conductance of insulating materials*

ASTM D1599, *Standard test method for resistance to short-time hydraulic failure pressure of plastic pipe, tubing, and fittings*

3 Terms and definitions

For the purposes of this part of ISO 14692, the terms and definitions given in ISO 14692-1 and the following apply.

3.1
fabrication
construction of the piping system (and pipeline) on site from either individual components and/or spool pieces

NOTE Individual components may be pipes, tees, bends, etc.

4 Symbols and abbreviated terms

The symbols and abbreviated terms given in ISO 14692-1 apply.

5 Fabrication and installation

5.1 Delivery, inspection and documentation of GRP piping

This part of ISO 14692 assumes that the fittings and pipes have been correctly manufactured and inspected according to the criteria given in ISO 14692-2.

The dimensions of the components and spools shall be available for the installer and operator. The quantity, qualified pressure, 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 not complying with the purchase order shall be reported to 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 may 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 that at least six months remains until the expiration of shelf-life. All fire protection material shall be inspected to ensure that the original packaging is not damaged.

5.2 Handling and storage

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

5.3 System design documentation

The principal shall provide the installer with the following information, which shall include but not be limited to

a) operating and design parameters:

   1) design pressure;

   2) design temperature;

   3) T_g of the resin used in component manufacture;

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

   5) qualified pressure of each component and minimum qualified pressure in 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;

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.

5.4 Installer requirements

5.4.1 Personnel qualification

All pipe, fittings and related items shall be installed by qualified GRP pipe fitters 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 D.

5.4.2 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. The installer shall follow the health and safety guidance given in Annex F.

5.5 Installation methods

5.5.1 General

Installation methods shall be agreed between the principal and the manufacturer. Copies of installation methods, procedures and quality plans shall be available on-site before work commences.

5.5.2 Cutting

GRP pipe of nominal diameter up to 100 mm may be cut with a hacksaw, using guides to ensure a square cut. For nominal diameters above 100 mm, an abrasive cutting disc shall be used. The squareness of the cut shall be checked. Pipe of nominal diameter up to 100 mm shall be square to within 1,5 mm. Cuts on larger pipes shall be square to within 3,0 mm. The installer should ensure that the cut end is coated with resin.

For adhesive-bonded connections, the pipe end shall be machined with a pipe shaver. Each manufacturer has specialized equipment for shaving spigots. The pipe end shall be shaved to the manufacturer's recommendations regarding angle, diameter, length and eccentricity.

5.5.3 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 will not necessarily match the pipe outside diameters. The use of saddles and elastomeric pads may allow the use of standard-size supports.

The following guidelines to GRP piping support should 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 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.

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

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

5.5.4 Installation

5.5.4.1 General requirements

The requirements for the handling of piping components are identical to those given in 5.2. Before installation, all piping components shall be inspected for damage as described in 5.1.

All piping components shall as far as possible be installed so that they are stress-free; therefore:

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.

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

a) site transport and handling equipment limitations;

b) installation and erection limitations;

c) 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. The “cut-to-fit” dimension shall be 150 mm of pipe additional to the length shown on the piping drawings. For hook-up spools, the “cut-to-fit” dimension shall be a minimum of 250 mm in each global direction. “Cut-to-fit” lengths shall be left square and plain.

The installer shall give due consideration to the following:

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 ensure that valves or other heavy attached equipment are independently supported;

c) 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.

d) 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;

e) delays caused by the time required for adhesive and 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;

f) 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;

g) the need to prevent overheating of the GRP pipe material by electric surface heating, if applied. Heat tracing should be 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. Care shall be taken that the tracing is not wound too tightly onto the pipework or it may be damaged when the pipe expands;

h) provision of suitable joints to facilitate isolation or access to the pipe for maintenance purposes.

High levels of supervision and inspection shall be adopted for piping which will be difficult to repair on site (e.g. ballast lines due to be cast in concrete, and piping in ballast water tanks).

5.5.4.2 Components fabricated on-site

All processes used to fabricate spoolpieces and components on-site, e.g. mitred elbows and laterals, shall have been qualified according to procedures given in 6.2.3.3 of ISO 14692-2:2002.

5.5.4.3 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	± 0,3	± 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	± 4	± 3	± 0,5
1 000 to 1 200	± 10	± 5	± 0,15	± 6	± 3	± 0,5
The maximum gap shall be limited to 6 mm.						

Table 2 — Acceptable tolerances for misalignment of flanges during installation

Dimensions in millimetres

Misalignment	Tolerances	
	Diameter range	
	50 to 300	300 to 1 200
Flange misalignment	± 1,6	± 3,2
Separation between spools	± 1	± 1

5.5.4.4 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 as it is installed according to the requirements documented by the system designer (see 5.3).

The installer shall measure one or more of the following properties as required:

a) continuity along the component between earth-bonding points;

b) maximum resistance to earth from a point on the inside of the pipe;

c) maximum resistance to earth from a point on the outside of the pipe or the fire-protective coating or thermal insulation cladding;

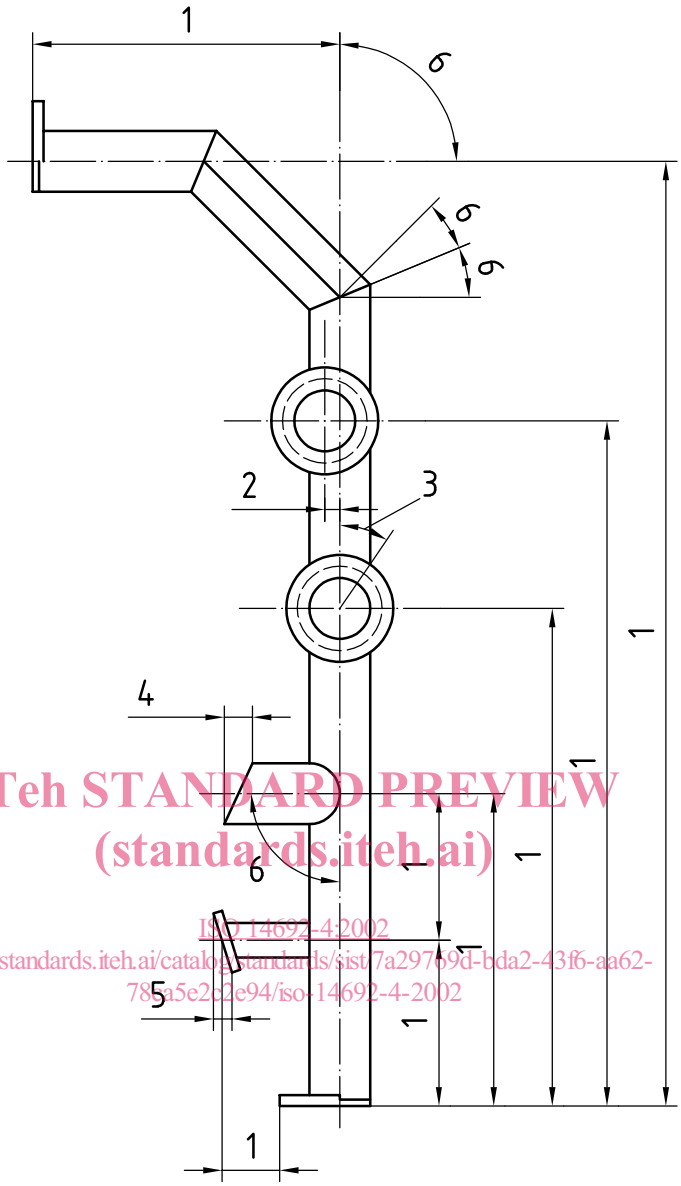
d) maximum resistance to earth of metal components located on the pipe;

e) recommended maximum distance between earthing points, based on the conductivity properties of the pipe system;

f) maximum surface resistivity on the outside of the pipe or the fire-protective coating or thermal insulation cladding;

g) charge-shielding properties of the pipe;

h) charge-decay properties of the outside surface of the pipe or the fire-protective coating or thermal insulation cladding.



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 — Toleranced dimensions

The installer shall take into account the manufacturer's recommended methods for applying earth-grounding straps and ensuring reliability of the conductivity path and/or earth bonding during installation and service.

If required, and after ensuring the inside and outside of the pipe are dry, the resistance at a point on the surface or earth-bonding point shall be measured using a suitable megohmmeter with a minimum scale division of less than $1 \times 10^6\ \Omega$. The voltage should preferably not be more than 1 500 V.

A voltage may be used which is higher than that used for qualification (100 V), to enable advantage to be taken of possible voltage breakdown of the resin coating for the in-service component, which may reduce the resistance to earth.

Electrical contact with the pipe shall be with a suitable electrode and shall be connected with the megohmmeter. The electrode shall provide the necessary conductivity to the surface of the pipe without abrading the material to achieve better electrical contact, unless required as part of the installation procedure, for example to apply an earth-grounding strap to the pipe.

Examples of means of electrical contact include conductive paints, conductive adhesive tape and brine-soaked sponges held in place with clamps. The resistance to earth shall be less than the value specified in the system design documentation (see 5.3). On completion of the tests, all conductive materials used for testing that have been applied to pipes that do not already have or cannot achieve a C2b classification shall be completely removed, e.g. conductive adhesive tape. Conductive materials applied to pipes with a C2b classification should preferably also be removed.

NOTE 1 Removal is to prevent such materials acting as isolated electrical conductors on the surface of the pipe.

If conductivity is provided by an embedded network of conducting elements within the wall of the component, the installer shall verify that there is electrical continuity along the component between earth-bonding points.

If conductivity is provided by use of an external conductive paint, the installer shall verify that the coating is continuous between earth-bonding points. The conductivity (ohms per metre) and resistance to earth (ohms) shall be less than the values specified in the system design documentation (see 5.3).

If required, and after ensuring the outside of the pipe is dry, the surface resistivity shall be measured in accordance with ASTM D257 and shown to be less than 1×10^9 Ω.

If required, and after ensuring the outside of the pipe is dry, the charge-decay properties shall be measured in accordance with 6.6.3.4 of ISO 14692-2:2002.

If required, and after ensuring the outside of the pipe is dry, the charge-shielding properties shall be measured in accordance with 6.6.3.3 of ISO 14692-2:2002.

NOTE 2 The charge-shielding test can be impractical in some situations because of the high voltage required.

If required, the installer shall coat the piping with a suitable conductive paint to provide the necessary electrical conductivity. The maximum size of uncoated area, in regions on the pipe that are intended to be painted, shall not be more than 100 cm^2. The coating shall be effective over the design life and shall not be impaired by normal service, handling or installation. The installer shall provide evidence of the durability of the coating.

The conductive coating should preferably be applied after hydrotesting, to facilitate inspection of possible leaks. Before the coating is applied to any piping components, the surfaces shall be free from moisture, grease or any other contaminants. The coating shall be continuous between earthing points, with no isolated patches.

If the GRP is coated with a conductive paint, there shall be a reliable electrical bond between the pipe and metal objects attached to the pipe, for example deluge nozzles and support hangers. Reliance should not be placed on the integrity of paint applied over a fitting, since a crack in the paint may result in the formation of an isolated conductor. In these situations, an independent means of providing a good conductive path between the pipe and support is necessary.

5.5.4.5 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.

5.5.5 Fittings fabricated on-site

It is permissible to fabricate fittings, e.g. tee pieces and elbows, on-site, provided that

a) lamination procedures are qualified according to 6.2.3.3 of ISO 14692-2:2002 using raw materials, lamination techniques, curing schedules, etc., as applicable, during on-site fabrication,

b) the piping system is designed to operate at a pressure less than that given in Table 3. The use of higher pressures shall be in agreement with the principal.

Table 3 — Low-pressure as a function of diameter

Diameter mm	Design pressure MPa (bar)
25 to 600	0,8 (8)
600 to 1 200	0,4 (4)
> 1 200	0,2 (2)

5.5.6 Jointing

5.5.6.1 Joint selection

Various types of bonded and mechanical joints are available. These are proprietary but can be categorized into the following types:

a) adhesive-bonded joints;

b) laminated joints;

c) elastomeric seal joints (with/without locking strips);

d) flanged joints;

e) other mechanical joints;

f) metallic/GRP interfaces;

g) threaded joints.

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

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

— 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 the assembly of joints is given in Annex C.