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

Part 3:
System design

Industries du pétrole et du gaz naturel — Canalisations en plastique renforcé de verre (PRV) —

Partie 3: Conception des systèmes

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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 second edition cancels and replaces the first edition (ISO 14692-3:2002), which has been technically revised. It also incorporates the Technical Corrigendum ISO 14692-3:2002/Cor 1:2005.

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*.

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

Introduction

The objective of this document is to ensure that piping systems, when designed using the components qualified in ISO 14692-2, will meet the specified performance requirements. These piping systems are designed for use in oil and natural gas industry processing and utility service applications. The main users of the document will be the principal, design contractors, suppliers contracted to do the design, certifying authorities and government agencies.

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

Part 3:
System design

1 Scope

This document gives guidelines for the design of GRP piping systems. The requirements and recommendations apply to layout dimensions, hydraulic design, structural design, detailing, fire endurance, spread of fire and emissions and control of electrostatic discharge.

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

Guidance on the use of this document can be found in Figure 1, which is a more detailed flowchart of steps 5 and 6 in ISO 14692-1:2017, Figure 1.

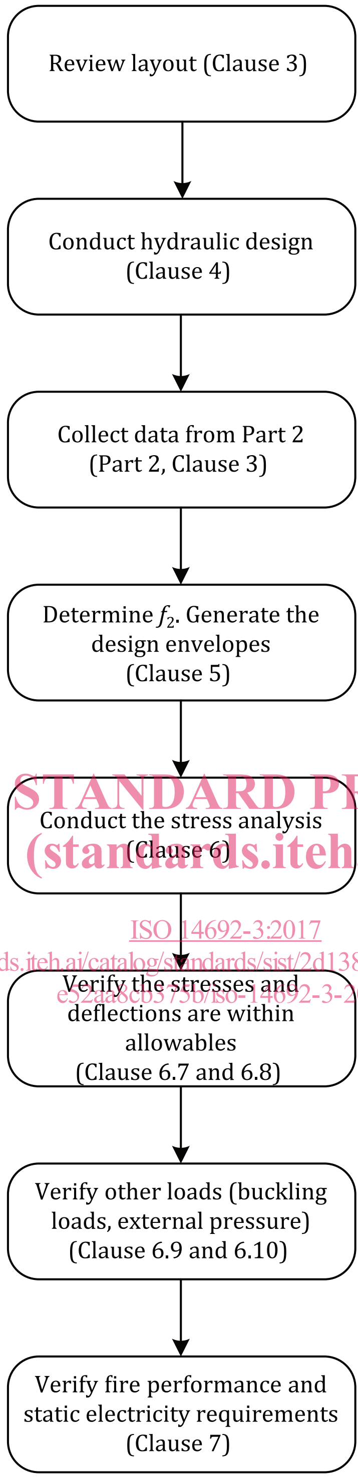

Figure 1 — Guidance on the use of this document

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 14692-1:2017, *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 D2992, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings*

ASTM D2412, *Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*

AWWA Manual M45, *Fiberglass pipe design*

3 Terms and definitions

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 Layout requirements

4.1 General

GRP products are proprietary and the choice of component sizes, fittings and material types can be limited depending on the supplier. Potential vendors should be identified early in design to determine possible limitations of component availability. The level of engineering support that can be provided by the supplier should also be a key consideration during vendor selection.

Where possible, piping systems should maximize the use of prefabricated spoolpieces to minimize the amount of site work. Overall spool dimensions should be sized taking into account the following considerations:

— limitations of site transport and handling equipment;

— installation and erection limitations;

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

The designer shall evaluate system layout requirements in relation to the properties of proprietary piping systems available from manufacturers, including but not limited to the following:

a) axial thermal expansion requirements;

b) ultraviolet radiation and weathering resistance requirements;

c) component dimensions;

d) jointing system requirements;

e) support requirements;

f) provision for isolation for maintenance purposes;

g) connections between modules and decks;

h) flexing during lifting of modules;

i) ease of possible future repair and tie-ins;

j) vulnerability to risk of damage during installation and service;

k) fire performance;

l) control of electrostatic charge.

The hydrotest provides the most reliable means of assessing system integrity. Whenever possible, the system should be designed to enable pressure testing to be performed on limited parts of the system as soon as installation of those parts is complete. This is to avoid a final pressure test late in the construction work of a large GRP piping system, when problems discovered at a late stage would have a negative effect on the overall project schedule.

4.2 Space requirements

The designer shall take account of the larger space envelope of some GRP components compared to steel. Some GRP fittings have longer lay lengths and are proportionally more bulky than the equivalent metal component and may be difficult to accommodate within confined spaces. If appropriate, the problem can be reduced by fabricating the pipework or piping as an integral spoolpiece in the factory rather than assembling it from the individual pipe fittings.

If space is limited, consideration should be given to designing the system to optimize the attributes of both GRP and metal components.

4.3 System supports

4.3.1 General

GRP piping systems can 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 following requirements and recommendations apply to the use of system supports.

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

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

c) Where there are long runs, it is possible to use the low modulus of the material to accommodate axial expansion and eliminate the need for expansion joints, provided the system is well anchored and guided. In this case, the designer shall recognize that the axial expansion due to internal pressure is now restrained and the corresponding thrust loads are partly transferred to the anchors.

d) Valves or other heavy attached equipment shall be adequately and, if necessary, independently supported. When evaluating valve weight, valve actuation torque shall also be considered.

   NOTE Some valves are equipped with heavy control mechanisms located far from the pipe centreline and can cause large bending and torsional loads.

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

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

Pipe supports can be categorized into those that permit movement and those that anchor the pipe.

4.3.2 Pipe-support contact surface

The following requirements and recommendations apply to GRP piping support.

a) In all cases supports shall have sufficient length to support the piping without causing damage and shall be lined with an elastomer or other suitable soft material.

b) Point loads shall be avoided. This can be accomplished by using supports with at least 60° of contact.

c) Clamping forces, where applied, shall 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.

d) Supports should be preferably located on plain-pipe sections rather than at fittings or joints. One exception to this is the use of a "dummy leg" support directly on an elbow or tee (or piece of pipe).

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. Supports in direct contact with intumescent coatings can also alter the performance of the coating (i.e. prevent expansion of the coating under fire). This may require application of intumescent coatings to the pipe support itself in order to protect the pipe at the hanger or pipe support.

Pipe resting in fixed supports that permit pipe movement shall have abrasion protection in the form of saddles, elastomeric materials or sheet metal.

Anchor supports shall be capable of transferring the required axial loads to the pipe without causing overstress of the GRP pipe material. Anchor clamps are recommended to be placed between either a thrust collar laminated to the outer surface of the pipe or 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.

4.4 Isolation and access for cleaning

The designer should make provision for isolation and easy access for maintenance purposes, for example, for removal of scale and blockages in drains. The joint to be used for isolation or access should be shown at the design stage and should be located in a position where the flanges can in practice be jacked apart, e.g. it should not be in a short run of pipe between two anchors.

4.5 Vulnerability

4.5.1 Point loads

Point loads shall be minimized and the GRP piping locally reinforced where necessary.

4.5.2 Abuse

The designer shall give consideration to the risk of abuse to GRP piping during installation and service and the need for permanent impact shielding.

Sources of possible abuse include the following:

a) any area where the piping can be stepped on or used for personnel support;

b) impact from dropped objects;

c) any area where piping can be damaged by adjacent crane activity, e.g. booms, loads, cables, ropes or chains;

d) weld splatter from nearby or overhead welding activities.

Small pipe branches (e.g. instrument and venting lines), which are susceptible to shear damage, should be designed with reinforcing gussets to reduce vulnerability. Impact shielding, if required, should be designed to protect the piping together with any fire-protective coating.

4.5.3 Dynamic excitation and interaction with adjacent equipment and piping

The designer shall give consideration to the relative movement of fittings, which can cause the GRP piping to become overstressed. Where required, consideration shall be given to the use of flexible fittings.

The designer should ensure that vibration due to the different dynamic response of GRP (as compared with carbon steel piping systems) does not cause wear at supports or overstress in branch lines. The designer should ensure that the GRP piping is adequately supported to resist shock loads that can be caused by transient pressure pulses, e.g. operation of pressure safety valves, valve closure etc. Reference [8] provides further guidance.

4.5.4 Exposure to light and ultraviolet radiation

Where GRP piping is exposed to the sun, the designer shall consider whether additional ultra violet radiation (UV) protection is required to prevent surface degradation of the resin. If the GRP is a translucent material, the designer should consider the need to paint the outside to prevent possible algae growth in slow-moving water within the pipe.

4.5.5 Low temperatures and requirements for insulation

The designer shall consider the effects of low temperatures on the properties of the pipe material, for example, the effect of freeze/thaw. For liquid service, the designer should particular pay attention to the freezing point of the internal liquid. For completely filled lines, solidification of the internal fluid can cause an expansion of the liquid volume, which can cause the GRP piping to crack or fail. For water service, the volumetric expansion during solidification or freezing is more than sufficient to cause the GRP piping to fail.

The pipe may need to be insulated and/or fitted with electrical surface heating to prevent freezing in cold weather or to maintain the flow of viscous fluids. The designer shall give consideration to:

a) additional loading due to mass and increased cross-sectional area of the insulation;

b) ensuring that electrical surface heating does not raise the pipe temperature above its rated temperature.

Heat tracing should be spirally wound onto GRP piping in order to distribute the heat evenly round the pipe wall. Heat distribution can be improved if aluminium foil is first wrapped around the pipe.

4.6 Fire and blast

The effect of a fire event (including blast) on the layout requirements shall be considered. The possible events to be considered in the layout design of a GRP piping system intended to function in a fire include the following:

a) blast overpressure, drag forces and projectile impacts;

b) fire protection of joints and supports;

c) interface with metal fixtures;

d) formation of steam traps in piping containing stagnant water, which would reduce the conduction of heat away by water;

e) jet fire;

f) heat release and spread of fire for piping in manned spaces, escape routes or areas where personnel are at risk;

g) smoke emission, visibility and toxicity for piping in manned spaces, escape routes or areas where personnel are at risk.

Penetrations (wall, bulkhead, deck) shall not weaken the division that they penetrate. The main requirements are to prevent passage of smoke and flames, to maintain structural integrity and to limit the temperature rise on the unexposed side. Penetrations shall therefore comply with the same requirements that apply to the relevant hazardous divisions. This requires the penetration to have been fire-tested and approved for use with the specific type of GRP piping under consideration.

5 Hydraulic design

5.1 General

The aim of hydraulic design is to ensure that GRP piping systems are capable of transporting the specified fluid at the specified rate, pressure and temperature throughout their intended service life. The selection of nominal pipe diameter depends on the internal diameter required to attain the necessary fluid flow consistent with the fluid and hydraulic characteristics of the system.

5.2 Flow characteristics

Fluid velocity, density of fluid, interior surface roughness of pipes and fittings, length of pipes, inside diameter of pipes, as well as resistance from valves and fittings shall be taken into account when estimating pressure losses. The smooth surface of the GRP can result in lower pressure losses compared to metal pipe. Conversely, the presence of excessive protruding adhesive beads will increase pressure losses.

5.3 General velocity limitations

When selecting the flow velocity for the GRP piping system, the designer shall take into account the following concerns that can limit velocities in piping systems:

a) unacceptable pressure losses;

b) prevention of cavitation at pumps and valves;

c) prevention of transient overloads (water hammer);

d) reduction of erosion;

e) reduction of noise;

f) reduction of wear in components such as valves;

g) pipe diameter and geometry (inertia loading).

For typical GRP installations, the mean linear velocity for continuous service of liquids is between 1 m/s and 5 m/s with intermittent excursions up to 10 m/s. For gas, the mean linear velocity for continuous service is between 1 m/s and 10 m/s with intermittent excursions up to 20 m/s. Higher velocities are acceptable if factors that limit velocities are eliminated or controlled, e.g. vent systems that discharge into the atmosphere.

