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

Part 2: Qualification and manufacture

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

Partie 2: Qualification et fabrication
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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 14692-2:2002), which has been technically revised. It also incorporates the Technical Corrigendum ISO 14692-2:2002/Cor 1:2005.

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

The objective of this document is to enable the purchase of GRP components with known and consistent properties from any source. Main users of this document will be the principal and the manufacturer, certifying authorities and government agencies.

The qualification programme and the quality programme are the most significant clauses in this document.
Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping —

Part 2: Qualification and manufacture

1 Scope

This document gives requirements for the qualification and manufacture of GRP piping and fittings in order to enable the purchase of GRP components with known and consistent properties from any source. It is applicable to qualification procedures, preferred dimensions, quality programmes, component marking and documentation.

This document 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 834-1, Fire-resistance tests — Elements of building construction — Part 1: General requirements

ISO 1172, Textile-glass-reinforced plastics — Prepregs, moulding compounds and laminates — Determination of the textile-glass and mineral-filler content — Calcination methods

ISO 4901, Reinforced plastics based on unsaturated-polyester resins — Determination of the residual styrene monomer content, as well as the content of other volatile aromatic hydrocarbons, by gas chromatography

ISO 11357-2, Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature and glass transition step height

ISO 11359-2, Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature

ISO 14130, Fibre-reinforced plastic composites — Determination of apparent interlaminar shear strength by short-beam method


API 15HR, Specification for high pressure fiberglass line pipe, Fourth Edition

ASME RTP-1-2007, Reinforced thermoset plastic corrosion-resistant equipment

ASTM D638, Standard test method for tensile properties of plastics
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

4 Manufacturer's declarations

4.1 Procedure

Prior to the start of the qualification programme, the manufacturer shall declare:

a) $G_{xx}$;

b) $MPR_{xx}$;

c) the long term envelope data points;

d) the threshold envelope data points;

e) dimensional data;

f) baseline values for degree of cure, barcol hardness (GRUP and GRVE only) and glass content, where applicable.

The data shall be based on a standard design life of 20 years. Figure 1 provides a flowchart of the procedure for declaring the manufacturer's data.
Manufacturer conducts long term regression testing (4.2) on a single pipe size and pressure class

For GRE, temperature is = 65 °C. For GRUP and GRVE, temperature is = 21 °C

Manufacturer calculates the measured gradient and identifies a suitable $S_{h,LT,2:1,xx}$

Manufacturer uses the long term regression data to select and declare a gradient (4.3 and Annex A)

Manufacturer uses the long term regression data to declare MPR$_{xx}$ using Formula (1) or (2) in ISO 14692-1

For GRE, declare MPR$_{65}$. For GRUP and GRVE, declare MPR$_{21}$. MPR$_{xx}$ may also be declared at other temperatures

The calculation of $\sigma_{h,LT,2:1,xx}$ is redundant. $\sigma_{h,LT,2:1,xx}$ is first determined by the manufacturer using the regression data. MPR$_{xx}$ is then calculated using Formula (1) or (2) in ISO 14692-1. $\sigma_{h,LT,2:1,xx}$ is then re-validated using Formula (C.3) and the manufacturer’s published value of MPR$_{xx}$.

Manufacturer calculates $S_{h,LT,2:1,xx}$ [Annex C, Formula (C.3)]

Manufacturer conducts the R=Rtest 1 000 hr survival test at the default temperature. See C.3. Calculate $\sigma_{h,LT,Rtest,xx}$ and $\sigma_{a,LT,Rtest,xx}$.

Continued
Manufacturer calculates the remaining long term envelope data points, $\sigma_{h,LT,1:0,xx}$, $\sigma_{a,LT,0:1,xx}$ and $\sigma_{a,LT,0:-1,xx}$. See Annex B.

Manufacturer uses the survival test qualification data to generate long term envelope data points at other temperatures (Annexes B and C).

If survival tests are only conducted at the design temperature, additional long term envelope data points are not calculated.

Manufacturer declares DN, ID, $D_{r,min}$, $t_{c,min}$, $t_0$, laying lengths and bend radii (4.7)

Proceed to Clause 5 and Figure 2 for the qualification programme.

**Figure 1 — Procedure for declaring manufacturer's data**

### 4.2 Long term regression testing

The manufacturer shall provide at least one full regression curve as per ASTM D2992 as modified in this subclause and in 5.1. The regression curve shall be at 65 °C or higher for GRE and 21 °C or higher for GRUP or GRVE.

The manufacturer’s gradient from the full regression curve shall be compared with the values in Table A.1 and a gradient can be selected per the process in Annex A.

NOTE 1 The one full regression curve does not have to be at or above the design temperature of the project. For example, the enquiry sheet specifies a design temperature of 93 °C and the manufacturer has a full regression curve at 85 °C for GRE-Aliphatic Amine. Since the resin matrix is GRE and the temperature of the full regression curve is above 65 °C, the data are acceptable. On the other hand, validation of the long term envelope via survival tests would have to be performed at the design temperature of the project.

The manufacturer shall conduct the long term regression on either a plain pipe or a pipe+joint, for one pipe diameter only, the diameter to be determined by the manufacturer.

NOTE 2 For economical and practical reasons, long term regression testing is typically conducted on small diameters. The recommended minimum pipe size is DN50. Data seems to be more consistent as the size increases (i.e. DN100 test results seem to be more consistent than DN50 test results).
The $D_{r,\text{min}}/t_{r,\text{min}}$ ratio of the pipe size shall be within the range of published $D_{r,\text{min}}/t_{r,\text{min}}$ ratios that are to be qualified. Ideally, the $D_{r,\text{min}}/t_{r,\text{min}}$ ratio of the pipe size should be close to the average $D_{r,\text{min}}/t_{r,\text{min}}$ ratio of all of the pipe sizes to be qualified. It is not desirable to have the $D_{r,\text{min}}/t_{r,\text{min}}$ ratio of the pipe size at either extreme.

The test fluid shall be potable water. For testing completed prior to the publication of this document, the test fluid may be salt water. In this case, the salt content shall be specified and shall not be greater than 35 g/L. The intention of this requirement is to allow validation of existing test data, but to require potable water for future testing. Potable water is a more aggressive test medium than salt water. Test data using mineral oil should be rejected since mineral oil is not a degrading agent to the bond between the glass fibres and the resin matrix.

All tests shall be conducted with unrestrained (i.e. "free") ends.

### 4.3 Gradient, $G_{xx}$

The manufacturer shall declare gradient, $G_{xx}$, in accordance with Annex A.

### 4.4 MPR$_{xx}$

MPR$_{xx}$ shall be defined in accordance with ISO 14692-1:2017, 4.1.

For design temperatures in excess of 65 °C for GRE and 21 °C for GRUP and GRVE, the manufacturer shall also publish MPR$_{xx}$ at the design temperature or higher.

The following shall be taken into account:

a) Default temperatures are 65 °C (MPR$_{65}$) for GRE and 21 °C (MPR$_{21}$) for GRVE and GRUP. For clarity, MPR shall always be published with a temperature subscript (e.g. MPR$_{65}$ or MPR$_{21}$, not MPR).

b) The default temperature for GRE is established at 65 °C since this temperature is at or above the design temperature for many typical GRE applications and since many manufacturers have conducted qualification testing for pressure at this temperature.

c) The default temperature for GRUP is established at 21 °C since there are many applications for GRUP near ambient temperature and the amount of qualification testing for pressure by manufacturers at 65 °C is less than that at 21 °C to 50 °C.

d) GRVE can be suitable for applications at temperatures above 65 °C. However, the amount of qualification testing for pressure above 65 °C by manufacturers is very small. Like GRUP, there is more qualification data between 21 °C to 50 °C, thus the default temperature for GRVE is established at 21 °C.

e) The manufacturer uses the survival tests to validate MPR$_{xx}$ (see 5.3.1).

### 4.5 Partial factors

#### 4.5.1 Partial factor for design lifetime, $A_0$

The partial factor for design lifetime, $A_0$, is specified in ISO 14692-3:2017, 6.1.1.

#### 4.5.2 Partial factor for chemical degradation, $A_2$

The partial factor for chemical degradation, $A_2$, shall be 1.0.

**NOTE 1** It is the resin rich liner, not the structural cage, that is designed to prevent chemical degradation. A partial factor applied to the reinforced wall thickness would provide little to no value in preventing chemical degradation.