BS EN ISO 14692-1:2017

BSI Standards Publication

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

Part 1: Vocabulary, symbols, applications and materials (ISO 14692-1:2017)

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National foreword

This British Standard is the UK implementation of EN ISO 14692-1:2017. It is identical to ISO 14692-1:2017. It supersedes BS EN ISO 14692-1:2002, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/-/6, Processing equipment and systems for petroleum and natural gas industries.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 94759 9

ICS 75.200; 01.040.75; 83.140.30

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2017.

Amendments/corrigenda issued since publication

Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 14692-1

September 2017

ICS 75.200; 83.140.30

Supersedes EN ISO 14692-1:2002

English Version

Petroleum and natural gas industries - Glass-reinforced plastics (GRP) piping - Part 1: Vocabulary, symbols, applications and materials (ISO 14692-1:2017)

Industries du pétrole et du gaz naturel - Canalisations en plastique renforcé de verre (PRV) - Partie 1: Vocabulaire, symboles, applications et matériaux (ISO 14692-1:2017)

Erdöl- und Erdgasindustrie - Glasfaserverstärkte Kunststoffrohrleitungen (GFK) - Teil 1: Begriffe, Symbole, Anwendungen und Werkstoffe (ISO 14692-1:2017)

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European foreword

This document (EN ISO 14692-1:2017) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2018 and conflicting national standards shall be withdrawn at the latest by March 2018.

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Endorsement notice

The text of ISO 14692-1:2017 has been approved by CEN as EN ISO 14692-1:2017 without any modification.

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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).

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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 14692-1:2002), which has been technically revised.

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

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Introduction

0.1 General

The objective of ISO 14692 (all parts) is to provide the oil and gas industry, as well as the supporting engineering and manufacturing industry, with mutually agreed specifications and recommended practices for the purchase, qualification, manufacturing, design, handling, storage, installation, commissioning and operation of GRP piping systems.

This document, provides guidance in the use and interpretation of the other parts of ISO 14692. This document contains the following annexes:

— Annex A (informative) explaining the principle;

— Annex B (informative) providing guidance on scope limitations;

— Annex C (normative) containing the enquiry sheet;

— Annex D (normative) providing wall thickness definitions;

— Annex E (informative) describing selection of part factor $f_{3,est}$ in bid process;

— Annex F (informative) containing a worked example.

0.2 Basic steps in use of ISO 14692 (all parts)

Figure 1 identifies the eight basic steps involved in the use of ISO 14692 (all parts) that are further explained below.

Step 1: The bid process. The principal completes an enquiry sheet (see Annex C) that defines the design pressures and temperatures of the piping system as well as the application, required pipe sizes and required components (bends, tees, reducers, flanges, etc.). The principal also verifies that the scope of the application is within the limits of ISO 14692 (all parts) (see Annex B). The principal and manufacturer also comes to an agreement on the value of the estimated value of the part factor $f_{3,est}$ (see Annex E).

In some cases, the manufacturer can wish to offer a product that 1) meets or exceeds the requirements in the enquiry sheet and 2) has already been manufactured, qualified and inspected per ISO 14692-2. In this case, Steps 2 through 4 would not need to be repeated.

Step 2: Manufacturer's data. Recognizing that long-term regression testing can easily take two or more years to complete, the manufacturer will most likely have already selected target values for MPR_{xx}, the long-term envelope(s) and the minimum reinforced wall thicknesses. The manufacturer determines the appropriate gradient and $rd_{1\,000,xx}$ can then be calculated to suit the survival test duration. Additional basic data such as pipe sizes, wall thicknesses, SIFs, production processes and jointing instructions are also provided.

Step 3: Qualification process. The manufacturer conducts survival tests to qualify the pressure and temperature. If applicable, the manufacturer also qualifies fire performance and electrical conductivity properties. Elastic properties, potable water certification, impact and low temperature performance are also addressed in this step. Just as in Step 2, the manufacturer can have already completed part or all of the qualification process prior to Step 1.

Step 4: Quality programme. The basic requirements for the manufacturer's quality management system are defined.

Step 5: Generate envelopes. This is the first major step in ISO 14692-3. Partial factors and part factors are identified and combinations of these factors are determined. Formulae are then provided to calculate the design envelope(s).

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Step 6: Stress analysis. The flexibility factors and SIFs to be used in the stress analysis are identified. The allowable values for vertical deflection, stresses and buckling are also defined. An analytical formula for external pressure is provided.

Step 7: Bonder training and assessment. This is the first major step in ISO 14692-4 where the bonder training and assessment process is defined.

Step 8: Installation, field hydrotest. This is the last major step where installation issues are addressed.

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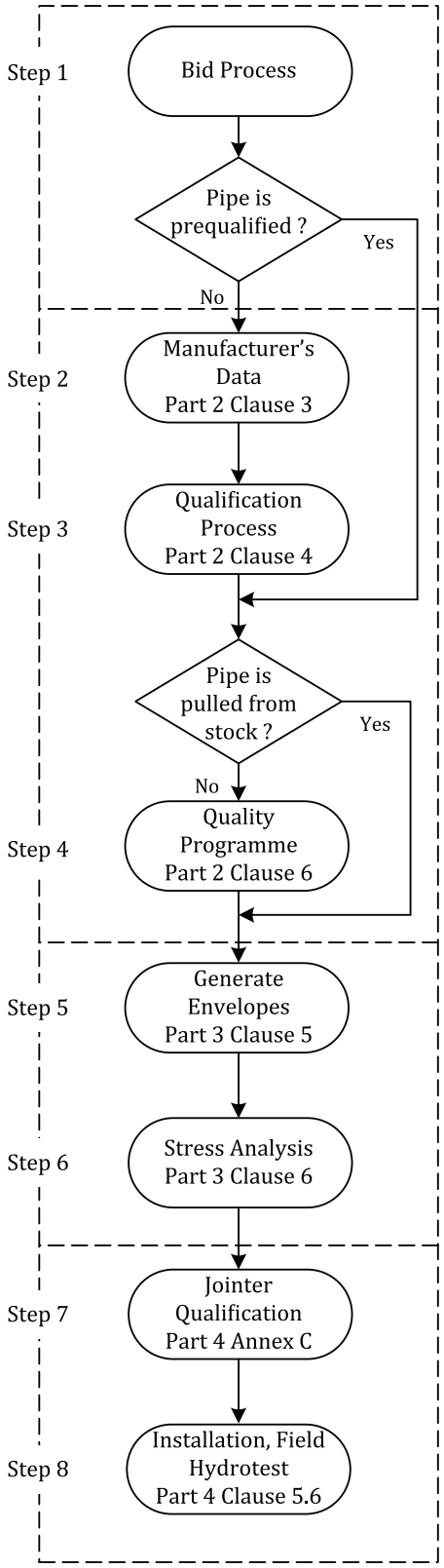

Concepts

Enquiry sheet (Part 1 AnnexD)
Estimated f_3 (Part 1 Annex F)
Scope limits (Part 1 Annex C)
A_0, A_2, A_3, MPR_{xx} (Part 1, 3.1 and 3.2; Part 2, 3.3 and 3.4)

Pipe, fittings and joints that have already been qualified per ISO 14692-2 would not need to repeat steps 2 and 3. Manufacturer would select a product with an MPR_{xx} to meet the requirements in the Entquiry sheet

Long term envelopes (Part 2, 3.5 and AnnexD)
Gradients and $rd_{1000,xx}$ (Part 2, 3.2 and Annexes B and C)
$D_{r,min}$, $t_{r,min}$, *SIFs* (Part 2, 3.6, 3.8)
Production processes and jointing instructions (Part 2, 3.9)

Scaling rules (Part 2, 4.2)
Product qualification (Part 2, 4.3)
Elastic properties (Part 2, 4.4)
Fire performance, electrical conductivity, other (Part 2, 4.5)

Pipe, fittings and joints that have already been inspected per ISO 14692-2 would not need to repeat step 4

Mill hydrostatic test, degree of cure, glass content, visual inspection and key component dimensions (Part 2, 6.1 and 6.2)

Combinations of partial factors and the f_2 part factor (Part 3, 5.1 thru 5.3)
Generate design envelope(s) (Part 3, 5.4)

Flexibility factors and *SIFs* (Part 3, 6.3 thru 6.5 and Annex A)
Allowable deflections and stresses (Part 3, 6.7 and 6.8)
External pressure/vacuum rating (Part 3, 6.9)

Based on manufacturer's jointing procedures
Theoretical and pratical exam terms (Part 4, Annex C)
Jointer qualification on representative joint types and sizes (Part 4, Annex C)

System design output (Part 3, Clause 8)
Field hydrotest (Part 4, 5.6)
Manufacturer's jointing instructions (Part 2, 3.9)
Installation instructions (Part 4, 5.5)
Jointer certificates (Part 4, Annex C)

Figure 1 — Guidance on the use of ISO 14692 (all parts)

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0.3 Other standards

GRP piping products are used in a wide variety of applications in both industrial and municipal service. For some applications, ISO 14692 (all parts) can be properly considered as the basis for piping and pipeline selection and design. In all applications, the selection of the appropriate standard for any particular application takes into consideration the design life of the project, the service temperature, the corrosive nature of the fluid, whether the intended installation is above ground or buried and what type of joining system is to be used. Depending on the service conditions, other GRP piping standards can be more appropriate and better suited than ISO 14692 (all parts) for the entire or part of the system. This is particularly the case for aqueous applications of both a municipal and industrial nature where the pipelines are generally buried and axial tensile loads are minimal.

Other widely used GRP piping standards include

— ISO 10639,

— ISO 10467,

— API 15HR,

— ASTM D3262-11,

— ASTM D3517-14,

— ASTM D3754-14,

— AWWA C950-07,

— EN 1796:2013, and

— EN 14364:2013.

ISO 14692 (all parts) is not intended to be applied to sewerage and drainage applications, although it can provide useful guidance in specific areas not addressed in alternative standards. ISO 14692 (all parts) is also not specifically intended for non-structural applications such as open drain systems and other low-pressure piping applications.

ISO 14692 (all parts) covers all the main components that form part of a GRP pipeline and piping system (plain pipe, bends, reducers, tees, supports and flanged joints) with the exception of valves and instrumentation.

0.4 Structure of ISO 14692 (all parts)

ISO 14692-2, ISO 14692-3 and ISO 14692-4 follow the individual phases in the life cycle of a GRP piping system, i.e. from qualification and manufacture through design to fabrication, installation, operation and decommissioning.

Each part is therefore aimed at the relevant parties involved in that particular phase.

— ISO 14692-1*: Vocabulary, symbols, applications and materials*. The scope is presented in Clause 1 and it provides guidance in the use of the other three parts of ISO 14692. Main users are envisaged to include all parties in the life cycle of a typical GRP piping system. This document should be used in conjunction with the part of specific relevance.

— ISO 14692-2*: Qualification and manufacture.* Its objective is to enable the supply of GRP components with known and consistent properties from any source. Main users of the document are envisaged to be the principal, the manufacturer, certifying authorities and government agencies.

— ISO 14692-3*: System design.* Its objective is to ensure that piping systems, when designed using the components qualified in ISO 14692-2, meet the specified performance requirements. Main users of

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the document are envisaged to be the principal, the manufacturer, design contractors, certifying authorities and government agencies.

— ISO 14692-4*: Fabrication, installation, inspection and maintenance*. Its objective is to ensure that installed piping systems meet the specified performance requirements throughout their service life. Main users of the document are envisaged to be the principal, the manufacturer, fabrication/installation contractors, repair and maintenance contractors, certifying authorities and government agencies.

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

Part 1: Vocabulary, symbols, applications and materials

1 Scope

This document defines the applications, pressure rating methodology, the classification of the products according to application, type of joint and resin matrix and the limitations to both the materials of construction and the dimensions. It also lists the terms, definitions and symbols used and provides guidance in the use and interpretation of ISO 14692-2, ISO 14692-3 and ISO 14692-4.

ISO 14692 (all parts) is applicable to GRP piping systems that 1) utilize joints that are capable of restraining axial thrust from internal pressure, temperature change and fluid hydrodynamic forces and 2) have a trapezoidal shape for its design envelope. It is primarily intended for offshore applications on both fixed and floating topsides facilities, but it can also be used for the specification, manufacture, testing and installation of GRP piping systems in other similar applications found onshore, e.g. produced-water, firewater systems and general industrial use.

For floating installations, reference is made to the design, construction and certification standards for the hull or vessel, since these can allow alternative codes and standards for GRP piping associated with marine and/or ballast systems. However, it is recommended that ISO 14692 (all parts) be used for such applications to the maximum degree attainable.

ISO 14692 (all parts) can also be used as the general basis for specification of pipe used for pump caissons, stilling tubes, I-tubes, seawater lift risers and other similar items.

Typical oil and gas industry applications for the use of GRP piping and pipelines include those listed in Table 1.

Table 1 — Typical current and potential GRP piping oil and gas applications

Ballast water	Hydrochloric acid
Boiler feed water	Inert gas
Brine	Jet-A fuel
Carbon Dioxide (CO_2)	Natural gas
Chlorine, gas, wet	Oil
Condensate (water and gas)	(Sour) Oil plus associated gas
Cooling water, sweet, brackish, seawater	Potable water
Demineralised water	Process water
Diesel fuel	Produced water
Drains	Seawater
Emulsions (water-oil-gas mixtures)	Service water
Fire water (ring main and wet or dry deluge)	Sewer (grey and red)
Formation water	Sodium hydroxide
NOTE Some applications, such as wet chlorine gas, hydrogen chloride gas, hydrochloric acid, sodium hydroxide and sodium hypochlorite, require a barrier liner and may require specific corrosion resistant resins. Consult the manufacturer for recommendations.	

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Table 1 *(continued)*

Fresh water	Sodium hypochlorite
Fuel	Sour water
Gas (methane, etc.)	Unstabilized oil
Glycol	Vents
Hydrocarbon (with or without associated gas)	Wastewater
Hydrogen chloride gas (HCl)	Water disposal
Injection water	
NOTE Some applications, such as wet chlorine gas, hydrogen chloride gas, hydrochloric acid, sodium hydroxide and sodium hypochlorite, require a barrier liner and may require specific corrosion resistant resins. Consult the manufacturer for recommendations.	

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

ISO 14692-3:2017, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 3: System design*

ISO 14692-4:2017, *Petroleum and natural gas industries — Glass-reinforced plastics (GRP) piping — Part 4: Fabrication, installation and operation*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the following terms and definitions 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/

3.1 General terms

3.1.1
authority having jurisdiction
third-party organization required to be satisfied with the standard of engineering proficiency and safety of a project

EXAMPLE A classification society, verification body or government regulatory body.

3.1.2
contractor
party which carries out all or part of the design, engineering, procurement, construction and commissioning for a project or operation of a facility

Note 1 to entry: The *principal* (3.1.9) can undertake all or part of the duties of the contractor.

3.1.3
designer
party which carries out all or part of the design for a project or facility

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3.1.4
installer
party which carries out all or part of the construction and commissioning of composite piping installations and installation work for a project

3.1.5
installation inspector
person able to perform satisfactory and independent inspection of composite piping installations and installation work

3.1.6
installation supervisor
tradesman able to perform practical supervision of the installation and joining of composite piping

3.1.7
manufacturer
party which manufactures or supplies composite plain pipe and piping components to perform the duties specified by the contractoractive fire protection

3.1.8
operator
party which assumes ultimate responsibility for the operation and maintenance of the piping system

Note 1 to entry: The operator can be the same as the *principal* (3.1.9) or principal's agent.

3.1.9
principal
party that initiates the project and ultimately pays for its design and construction

Note 1 to entry: The principal generally specifies the technical requirements and is ultimately responsible for ensuring that safety and all other issues are addressed. The principal can also include an agent or consultant, authorized to act for the principal.

3.1.10
site
location where piping system is installed

3.2 Technical terms

3.2.1
accelerator
substance which, when mixed with a catalyst or a resin, will speed up the chemical reaction between catalyst and resin

Note 1 to entry: The misuse of a cobalt mixture directly with a peroxide (e.g methyl ethyl ketone peroxide (MEKP) -catalyst) might cause an explosion or fire.

3.2.2
active fire protection
method of extinguishing fire by application of substances such as halon, water, carbon dioxide, foam, etc.

3.2.3
adhesive joint
adhesive bond
glued joint
socket joint
rigid type of joint between two components made using an adhesive

Note 1 to entry: An adhesive joint generally consists of a slightly conical (tapered) bell end and a machined (cylindrical or tapered) spigot end.

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3.2.4
anisotropic
exhibiting different properties when tested along axes in different directions

3.2.5
carbon fibre
fibre produced by the pyrolysis of organic precursor fibres, such as rayon, polyacrylonitrile, in an inert environment

3.2.6
cavitation
formation of pockets of vapour in a liquid that suddenly collapse, causing very high localized pressures which can lead to serious erosion of boundary surfaces

3.2.7
chemical-resistant glass
ECR glass
Boron-free glass
C glass
AR (acid resistant) glass
glass fibre or synthetic veil having a specific chemical resistance against acids, alkalis or other aggressive chemicals

Note 1 to entry: Such glass can be used as a reinforcement for the resin-rich internal liner of GRP pipe or as a reinforcement in the structural portion of GRP pipe.

3.2.8
collapse pressure
external pressure differential which causes buckling collapse of a component

3.2.9
chopped roving
strands of glass fibre cut to a desired length from rovings

3.2.10
chopped strand mat
CSM
reinforcement structure in which short lengths of glass fibre tows, held together by an emulsion or powder binding agent, are dispersed in random directions within a single plane

Note 1 to entry: Chopped strand mat is not to be confused with chopped roving. The latter may not be in mat form and may be loose rovings from a chopper gun.

3.2.11
cure
change irreversibly the properties of a thermosetting resin by chemical reaction

Note 1 to entry: Examples of such chemical reaction are condensation, ring closure and addition.

Note 2 to entry: Cure can be accomplished by the addition of a curing agent and catalyst, with or without heat and pressure.

3.2.12
cure cycle
polymerization
time/temperature/pressure cycle used to cure a thermosetting resin system from a liquid to a solid

3.2.13
curing agent
catalytic or reactive agent that, when added to a resin, causes polymerization

Note 1 to entry: This is also called *hardener* (3.2.51), for epoxies.

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3.2.14
delamination
separation of two adjacent plies or layers of material in a laminate resulting from lack of adhesion

Note 1 to entry: Delamination occur either locally or covering a wide area.

3.2.15
design envelope
long-term envelope reduced by the part factor f_2 and the partial factors A_0, A_2 and A_3

3.2.16
design external pressure
maximum positive external pressure differential, i.e. external minus internal pressure, intended to be experienced by a component during its service life

3.2.17
design pressure
P_{des}
purchaser nominated maximum pressure to which a piping system is designed to operate at the nominated design temperature (T_{des}) and for the nominated design life (L_{des})

Note 1 to entry: P_{des} is typically considered as a sustained pressure, though an additional P_{des} occasional can also be nominated. P_{des} will be selected based on the maximum operating pressure plus a purchaser selected uplift a) to accommodate pressure uncertainty, b) to avoid triggering of pressure safety devices, c) to match the rating of attached piping or equipment and d) to provide a design margin for other purposes.

3.2.18
design temperature
T_{des}
for each design condition, maximum fluid temperature that can be reached during service

3.2.19
differential scanning calorimetry
DSC
method for determining the glass transition temperature of a polymer

3.2.20
dynamic mechanical thermal analysis
DMTA
method for determining the glass transition temperature of a polymer or *GRP* (3.2.44) component

3.2.21
earth, v, GB
ground, v, US
provide electrical contact with earth

3.2.22
E-glass
glass fibre normally used to reinforce *GRP* (3.2.44) pipes, consisting mainly of SiO_2, Al_2O_3 and MgO

3.2.23
elastomeric bell-and-spigot seal lock joint
rubber seal lock joint
rubber sealed key lock joint
joint connection made up of a spigot end and a socket end with “O” or lip-sealing rings and some axial restraining device capable of resisting the full thrust from internal pressure

3.2.24
electrically conductive
conductive
having a volume resistivity equal to or lower than 10^4 Ω·m

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3.2.25
environmental stress cracking
ESC
formation of cracks in a polymer or composite caused by exposure to a chemical or environment under stress

3.2.26
epoxide
epoxy
compound containing at least two epoxy or oxirane rings

Note 1 to entry: Chemically, an epoxy ring is a three-membered ring containing two carbon atoms and one oxygen atom.

Note 2 to entry: The most widely used epoxy resin is termed DGEBA (diglycidyl ether of bisphenol A). Epoxy resins are always used in conjunction with curing agents or hardeners, i.e. substances that react with the epoxy rings, producing hydroxyl groups and other products, and linking the originally linear molecules into a rigid three-dimensional network.

3.2.27
extrados
exterior curve of an elbow or torus

3.2.28
failure
loss of structural integrity and/or transmission of fluid leakage through the wall of a component or a joint

3.2.29
fibre
filamentary material with a finite length that is at least 100 times its diameter and prepared by drawing from a molten bath, spinning or deposition on a substrate

Note 1 to entry: Filaments are usually of extreme length and very small diameter, usually less than 25 µm. Normally, filaments are assembled as twisted (yarn) or untwisted (tow) bundles comprising hundreds or thousands of filaments.

3.2.30
filament winding
process for fabricating a composite structure in which continuous reinforcements, e.g. fibre tows, are either previously impregnated with a matrix material or impregnated during the winding

3.2.31
fire classification code
code designation of the fire performance of pipe component in terms of fire endurance and fire reaction properties

3.2.32
fire endurance
fire resistance
ability to maintain functional performance in a fire

3.2.33
fire-reaction property
material property which contributes to spread of fire, heat release and smoke/toxic emissions

3.2.34
fitter
jointer
pipe bonder
tradesman able to perform satisfactory and independent work in the installation and joining of composite piping

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3.2.35
fitting
pressure-tight fluid-containing component with a geometry different from straight pipe

EXAMPLE Flanges, tees, elbows, reducers and fabricated branch.

3.2.36
flame retardant
chemical that is used to reduce or eliminate the tendency of a resin to burn, keep and propagate fire

3.2.37
flange joint
mechanical joint with face flanges for which the bolt circle and face dimensions conform to a recognized standard

3.2.38
flexibility factor
ratio of the flexibility in bending of a component/fitting to that of the flexibility of a straight pipe of the same lamination, Young's modulus and thickness having a length corresponding to the developed length of the fitting

3.2.39
free-end testing
pressure-testing arrangement using pipe end closures of a type such that internal pressure produces axial, as well as hoop and radial, stresses in the component wall

Note 1 to entry: See also *restrained-end testing* (3.2.107).

3.2.40
function
ability of the piping system to perform its primary purpose, i.e. to deliver a minimum quantity of fluid at a specified minimum pressure

3.2.41
furnace test
test in a compartment furnace where the time-temperature curve to be followed is to a defined standard

3.2.42
gel coat
quick-setting resin applied either a) to the surface of a mould and gelled before lay-up or b) to the exterior of a laminate as part of the external corrosion barrier

Note 1 to entry: The gel coat becomes an integral part of the finished laminate, and is usually used to provide specific service characteristics [see *liner* (3.2.69)].

3.2.43
glass-fibre-reinforced epoxy
GRE
epoxy resin-based composite that is reinforced with glass fibre

3.2.44
glass-fibre-reinforced plastic
GRP
fibreglass
composite
reinforced plastic
reinforced thermosetting resin plastic
RTR plastic
polymeric resin-based composite that is reinforced with glass fibre

Note 1 to entry: The predominant glass fibre is *E-glass* (3.2.22).

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Note 2 to entry: ISO 14692 (all parts) is restricted to the use of thermosetting *resins* (3.2.116).

Note 3 to entry: GRE, GRUP and GRVE are types of GRP.

3.2.45
glass-fibre-reinforced unsaturated polyster
GRUP
unsaturated polyester resin-based composite that is reinforced with glass fibre

3.2.46
glass-fibre-reinforced vinyl ester
GRVE
epoxy vinyl ester resin-based composite that is reinforced with glass fibre

3.2.47
glass transition temperature
T_g
temperature at which the amorphous portion of the polymer undergoes a marked change in properties on passing from the rubbery to glassy state

Note 1 to entry: This observed change in properties is associated with the virtual cessation of local molecular motion in the polymer. Below their glass-transition temperature, amorphous polymers have many of the properties associated with ordinary inorganic glasses, while above this temperature the polymers possess rubbery characteristics.

3.2.48
gradient
slope
slope of internal pressure over time, on a logarithmic-logarithmic scale, of a static regression curve

Note 1 to entry: The slope, although negative, is published and used as a positive number.

3.2.49
grounding clamp
metal fitting attached to the pipe component to provide an electrical connection to earth

3.2.50
hand lay-up
process for fabricating a composite structure in which discontinuous reinforcements, e.g. woven mats, chopped strand mats, are impregnated with a matrix material and are manually applied on a mandrel or mold

3.2.51
hardener
substance or mixture added to a plastic composition to promote or control the curing action by taking part in it

Note 1 to entry: For epoxies, hardener is also called *curing agent* (3.2.13).

3.2.52
hazardous area
three-dimensional space in which a combustible or explolsive atmosphere can be expected to be present frequently enough to require special precautions for the control of potential ignition sources

Note 1 to entry: Hazardous areas are typically defined by local, national or international standards (e.g. the National Electric Code (NEC) in the United States).

3.2.53
heat-distortion temperature
HDT
temperature at which a standard test bar deflects a specified amount under a stated load

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3.2.54
heat flux
density of heat flow rate
quantity of heat divided by area and time

3.2.55
hydrocarbon pool fire
fire caused by ignition of a pool of hydrocarbon liquid

3.2.56
hydrotest
pressure test to verify the pressure-retention integrity of a piping system after installation

Note 1 to entry: Hydrotest is also used as a *leak test* (3.2.68).

Note 2 to entry: See *mill hydrostatic test* (3.2.78).

3.2.57
impregnate
saturate the reinforcement with a resin

3.2.58
incendive discharge
electrostatic spark discharge of sufficient energy to ignite a flammable atmosphere

3.2.59
integrity
minimum structural capability required to enable the piping system to fulfil its function

3.2.60
intrados
interior curve of an elbow or torus

3.2.61
intumescent
passive fire-protection coating which, in the presence of fire, expands to create an inert insulating "char" layer

3.2.62
jet fire
turbulent diffusion flame resulting from the combustion of a fuel continuously released with significant momentum in a particular direction

3.2.63
joint
means of connecting two or more components

EXAMPLE Plain pipe to a fitting, or plain pipe to plain pipe.

3.2.64
laminae
thin sheet of reinforcing fibres in a resin matrix built up into a flat or curved arrangement

3.2.65
laminate
unite laminae with a bonding material, usually using pressure and heat

Note 1 to entry: Normally used with reference to flat sheets, but can also refer to tubes. A product made by such bonding is referred to as a laminate.

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3.2.66
laminated joint
butt-and-wrap joint
butt-and-strap joint
butt-welded joint
joint consisting of plain-ended pipe and fittings laminated together with reinforcing fibres and resin/hardener mixture

3.2.67
laying length
actual length of a line, corresponding to the initial length plus the increase afforded by the fitting or integral joint when installed

3.2.68
leak test
pressure test to determine the presence of leaks at joints or within components of a piping system

Note 1 to entry: Usually carried out at a pressure lower than the *hydrotest* (3.2.56) and for a longer period.

3.2.69
liner
continuous resin-rich coating on the inside surface of a pipe or fitting component, used to protect the laminate from chemical attack or to prevent leakage under stress

Note 1 to entry: The liner can also be used to provide enhanced abrasion and erosion resistance.

3.2.70
long-term envelope
envelope that defines the stress levels that are just below those that can potentially cause irreversible damage during continuous or occasional loading conditions at a specified temperature

3.2.71
lower confidence limit
LCL
97,5 % lower bound value of the nominal long-term regression line for hydrostatic pressure or stress based on a 20-year lifetime

3.2.72
lower prediction limit
LPL
97,5 % lower bound value for an individual component failure, based on the long-term hydrostatic pressure or stress for a 20-year lifetime

Note 1 to entry: The LPL will always be lower than the *LCL* (3.2.71) for the nominal regression line (i.e. the prediction interval will always be larger than the confidence interval).

3.2.73
mandrel
core tool around which resin-impregnated reinforcement is wound to form pipes, fittings and structural shell shapes

3.2.74
maximum pressure rating
MPR_{xx}
pressure rating given by the manufacturer in product literature

Note 1 to entry: MPR_{xx} is the maximum pressure rating at sustained conditions for a 20-year design life at the temperature of xx °C. MPR_{xx} is the maximum catalogue value published by the manufacturer.

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3.2.75
matrix
homogeneous resin or polymer material in which the fibre system is imbedded in a laminar arrangement

3.2.76
mechanical joint
joint between GRP piping components which can resist thrust from internal pressure and is not made by bonding

Note 1 to entry: A mechanical joint typically involves use of proprietary devices.

Note 2 to entry: A *prescribed threaded joint* (3.2.98) is a type of mechanical joint.

3.2.77
megohmmeter
high-voltage instrument used for measuring electrical resistance

3.2.78
mill hydrostatic test
short-term hydrotest at the mill, or factory, used as a quality control check which is carried out at a pressure above the design pressure

3.2.79
minor Poisson's ratio
ν_{ah}
hoop strain resulting from a stress in the axial direction

Note 1 to entry: GRP pipes will typically contract in the hoop direction when subjected to an axial stress.

3.2.80
modulated differential scanning calorimetry
MDSC
type of *DSC* (3.2.19) that enables reversible reactions to be distinguished from irreversible processes such as additional polymerization of the resin during the test

3.2.81
nominal diameter
DN
numerical designation of size that is common to all components in a piping system, other than components designated by outside diameters or by thread size

Note 1 to entry: It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

3.2.82
operating pressure
OP
normal or anticipated standard internal pressure difference, i.e. internal minus external pressure, to be experienced by the pipe or piping system which should not exceed the design pressure

3.2.83
ovality
irregularity of the circular section of a component, quantified by the difference in the largest and smallest cross-sectional axes

3.2.84
part factor
f_2
derating factor related to confidence in the pipework system, the nature of the application and the consequences of failure

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3.2.85
part factor
$f_{3,est}$
derating factor that de-rates a component, taking account of non-pressure-related axial loads, e.g. bending and externally-applied direct-acting axial forces so that the combined hoop and axial stresses are still within the design envelope for each individual load case

Note 1 to entry: $f_{3,est}$ is estimated at the bid stage. The $f_{3,est}$ part factor cannot be confirmed until a stress analysis is conducted. The $f_{3,est}$ part factor can vary from one load case to another.

3.2.86
passive fire protection
method of minimizing fire damage by use of sacrificial or non-combustible coatings

3.2.87
performance standard
defined limit placed on characteristics of materials, products or services

3.2.88
phenolic
class of polymer resins made from phenol and formaldehyde, and cured by air drying or heat baking

Note 1 to entry: Chemical resistance can be further increased via heat and catalyst treatment.

3.2.89
pipe support
pipe fixture or structural attachment which transfers the load from the pipe or structural attachment to the supporting structure or equipment

Note 1 to entry: Fixtures include hanging-type fixtures such as hanger rods, spring hangers, sway braces, counterweights, turnbuckles, struts, chains, guides and anchors; and bearing-type fixtures such as saddles, bases, rollers, brackets and sliding supports.

Note 2 to entry: Structural attachments include elements which are bonded or moulded into the pipe, such as clips, lugs, saddles, rings, clamps, clevises, straps and skirts.

3.2.90
piping
assemblies of piping components used to convey, distribute, mix, separate, discharge, meter, control or restrict fluid flows

3.2.91
piping component
component
mechanical element suitable for joining or assembly into a pressure-tight fluid-containing piping system

EXAMPLE Pipe, fittings, flanges, gaskets, bolting, valves, and devices such as expansion joints, flexible joints, pressure hoses, liquid traps, strainers and in-line separators.

3.2.92
piping system
interconnected piping subject to the same set or sets of design conditions

Note 1 to entry: The piping system also includes pipe supports, but does not include support structures.

3.2.93
pipeline system
pipe with components subject to the same design conditions and typically used to transport fluids between wells and field facilities, field facilities and processing plants, processing plants and storage facilities

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3.2.94
Poisson's ratio
major Poisson's ratio
ν_{ha}
axial strain resulting from a stress in the hoop direction

Note 1 to entry: GRP pipes will typically contract in the axial direction when subjected to a hoop stress.

Note 2 to entry: For GRP pipes wound at a 54° winding angle, the Poisson's ratio will typically be smaller in magnitude than the *minor Poisson's ratio* (3.2.79).

3.2.95
postcure
additional elevated-temperature cure, usually without pressure, to improve final resin properties and/or complete the cure or polymerization of the resin matrix, or decrease the percentage of volatiles in the compound

Note 1 to entry: In certain resins, complete cure and ultimate mechanical properties are attained only by exposure of the cured resins to temperatures higher than those of curing (typically within to 30 °C to 50 °C of the maximum possible T_g).

3.2.96
pot life
length of time that a catalysed thermosetting resin system retains a viscosity low enough to enable processing and sufficient reactivity to achieve specified properties after processing

3.2.97
potable water
water that is fit to drink

Note 1 to entry: In most developed countries, water supplied to commerce and industry is fit to drink even though a small amount is actually consumed or used in food preparation.

3.2.98
prescribed threaded joint
mechanical joint that complies with API 15 HR

Note 1 to entry: A prescribed threaded joint is a type of *mechanical joint* (3.2.76).

3.2.99
pressure rating
rated pressure
rating for a component, relating to its long-term resistance to failure when subjected to either static or standardized cyclic internal pressure loading

3.2.100
proportional limit
greatest stress that a material is capable of sustaining without deviation from linear proportionality of stress and strain

Note 1 to entry: The proportional limit can be different in the axial direction compared to the hoop direction.

3.2.101
qualification
process of demonstrating that a component is in accordance with the requirements of ISO 14692-2

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