

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 148

**Glass - Reinforced plastic Epoxy Resin Piping
materials (tubes and accessories)**

09	11/2016	New revision
08	05/2015	Organisation change - January 2015
07	10/2014	New revision
06	10/2012	New revision
00	03/2001	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/TEC	Managing entity: DSO/TEC/PVV
Other Approving entity(ies):	

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1. Scope

This document applies to the supply of piping materials (tubes and accessories) intended for the fabrication of networks carrying liquid products such as water, chemicals or drains at a temperature of less than 90°C, the diameters of which being from 1" to a maximum of 40".

The Manufacturer must provide a complete and homogeneous assembly that can be connected by flanges to steel piping.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ASME B16.47	Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
ASTM D1599	Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D1652	Standard Test Methods for Epoxy Content of Epoxy Resins
ASTM D2105	Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube
ASTM D2122	Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D2143	Standard Test Method for Cyclic Pressure - Strength of Reinforced, Thermosetting Plastic Pipe
ASTM D2196	Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer
ASTM D2310	Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2343	Standard Test Method for Tensile Properties of Glass Fiber Strands, Yarns and Rovings Used in Reinforced Plastics
ASTM D2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel - Plate Loading
ASTM D2471	Standard Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resins (Edition 1999)

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Reference	Title
ASTM D2563	Standard Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts
ASTM D2583	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D2992	Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D2996	Standard Specification for Filament Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting- Resin) Pipe
ASTM D4024	Specification for Machine Made Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D445	Standard Test method for kinetic Viscosity of Transparent and Opaque liquids (and calculation of Dynamic Viscosity)
ASTM D5421	Specification for Contact Molded Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D570	Standard Test for Water Absorption of Plastics
ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM G153	Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G90	Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight
ISO 11357-2	Plastics - Differential scanning calorimetry (DSC) - Part 2: Determination of glass transition temperature and glass transition step height
ISO 14692 (Parts 1; 2; 3; 4)	Petroleum and natural gas industries - Glass-reinforced plastics (GRP) piping - Parts 1; 2; 3; 4
ISO 16276-2	Corrosion protection of steel structures by protective paint systems - Assessment of, and acceptance criteria for, the adhesion/cohesion (fracture strength) of a coating - Part 2: Cross-cut testing and X-cut testing

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Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP PVV 107	Piping Stress Analysis
GS EP PVV 178	Design and erection of Glass Reinforced Plastic (GRP) piping system
GS EP SAF 337	Passive Fire Protection: basis of design

If there is a disagreement between this specification and one of these codes or standards, the Manufacturer must so inform the Company who will decide; it is understood that in this case, the more stringent requirement shall be assumed to apply in the absence of formal approval by the Company.

3. Definition

Manufacturer, Installer, Contractor, Designer, Principal are defined by [ISO 14692-1](#) (§ 2.1).

Engineering Company is the Designer and can be either the Contractor or the Manufacturer.

Company is the Principal as defined by [ISO 14692-1](#).

Managing Entity is as defined on the front page of present document.

4. Design

Design and erection of GRP piping system is covered by [GS EP PVV 178](#).

Dimensioned assembly drawings and/or isometric drawings are prepared by the Engineering Company.

The supporting of the piping must be determined by the Engineering Company on the basis of information furnished by the Manufacturer and according to [ISO 14692-2](#). The information provided by manufacturer must include standard drawings of supports, together with the general rules applicable to materials of the supply.

The Manufacturer is required to check these drawings, to perform related stress calculations and surge analysis, and to propose any appropriate changes or suggestions before fabrication.

Manufacturer shall indicate the minimum Allowable stress (pipe/fittings) guaranteed for the supplied products including bonded joints.

The Manufacturer and the Engineering Company shall adopt a detailed final version of these drawings.

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5. Fabrication

5.1 Structure of the tube

5.1.1 Inside layer (gel coat or liner)

This inside layer shall have a resin content of at least 70%. The gel coat may be reinforced by C glass cloth or woven polyester.

If present within the tube structure, it shall be at least 0.5 mm thick. The resin used shall be free of pigment - unless used for ultra violet protection - or other additives.

For use with fluids having a high content of especially corrosive chemicals (concentrated hydrochloric acid for instance), an inside layer shall be implemented. Its material and thickness suitability shall be demonstrated by qualification tests on pipes, fittings and flanges. The results of these tests shall be communicated to Managing Entity for approval.

For drinkable water systems, the internal lining, or other products in contact with the fluid, shall not alter the expected quality of water.

5.1.2 Layers providing mechanical strength

These layers shall be of glass-reinforced thermosetting resin. Generally, the same resin shall be used as for the gel coat. If not, the resins must be compatible and provide a bond as good as identical resins. The resin used must be pigment-free, unless pigments are used for ultra violet protection.

5.1.3 Outside layer

This generally consists of the same resin used as for the layer providing mechanical strength (layer made of pure resin, called "gel coat").

However, subject to the Managing Entity prior approval, the Manufacturer may use a "gel coat" containing the following additives:

- Pigments (for protection against UV)
- Graphite (to decrease the surface electrical resistivity)
- Antimony oxyde or alumina (to enhance the self extinguishing properties).

Carbon fibre may also be inserted in outside layer to insure electrical conductivity.

A supplementary layer may be proposed by the Manufacturer to enhance the surface finishing, the UV resistance performance or other function. The layer shall be subject to Managing Entity approval.

5.2 Raw materials

5.2.1 Resins

The only acceptable synthetic thermosetting resins are epoxy resins.

Isophthalic or orthophthalic polyester resins shall not be used.

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However, in the case of fluids having a high content of especially corrosive chemicals (acids or bases), reference shall be made to the Manufacturer's recommendations for the selection of the appropriate resin, which may then be an epoxy-based vinylester or isophthalic polyester and shall be subject to Managing Entity approval.

5.2.2 Glass fibers

Two types of glass, having different chemical compositions, shall be used to reinforce thermosetting resins (they are known as "C" glass and "E" glass):

- Inside layer
 - "C" glass is used in the form of light-weight fabrics (30 to 50 g/m²) to reinforce the gel coat.
 - Layers providing mechanical strength
 - "E" glass is a reinforcing glass for the layers of composite materials providing mechanical strength. It is used in various forms: rovings, mats, fabrics, chopped fibers.
 - Data sheet of glass fiber making the mechanical strength shall be available. Substitute to "E" glass shall exhibit better mechanical characteristics than "E" glass. Data sheets shall state the name and location of the production plant.
- "E-CR" glass may be used for all acidic or other corrosive services.

5.3 Fabrication processes for tubes and accessories

If a specific UV resistant coating is required the following shall be considered:

- The application conditions shall not impair the mechanical integrity of the component. Specific testing shall be settled for that purpose.
- The surface of the component shall be clean and dry before application of first coat (tie coat) and finish coat of painting system P06 of the **GS EP COR 350** or other agreed equivalent system.
- Adhesion test according [ISO 16276-2](#) shall be performed: only level 0 results are acceptable.

5.3.1 Tube fabrication processes

The tubes covered by this specification shall be made by filament winding of "rovings" of resin-impregnated glass. They must comply with the standard [ASTM D2996](#). These tubes must also belong to one of the following classes, described in [ASTM D2310](#):

- Type 1, Grade 1 (epoxy), Class A (no liner)
- Type 1, Grade 1 (epoxy), Class F (reinforced epoxy liner).

For the reciprocal filament winding, the usual winding angle is $54^\circ \pm 2^\circ$; other angles may be used with justification (calculation note).

Asymmetrical winding angles may be considered if they combine transversely and longitudinally oriented fibers (two different angles close to 90° and 0°).

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For continuous filament winding with rovings wound in the circumferential direction, randomly orientated chopped glass fibers are used for obtaining longitudinal strength. Axial tape (unidirectional 90°) reinforcement may be used as supplemental reinforcement to enhance the longitudinal strength.

The ends of the tubes must be removed if, because of the fabrication process, they have glass fibers wound at a different angle from those of the central portion of the tube.

5.3.2 Fabrication processes for accessories

The accessories covered by this specification are 45° elbows, 90° elbows, straight tees, reductions, couplings, collars for loose flanges, and fixed flanges.

The same materials as for the tubes shall be used for accessories.

The following fabrication processes may be used for these accessories:

- Filament winding
- Injection
- Contact moulding
- Press moulding.

All through the fabrication, the automatic or semi-automatic manufacturing process shall minimize any risk of lack of adhesion resulting from adverse or inappropriate distribution of filament winding.

Flanges are fabricated on a mould or directly by a piping filament winding process as per [ASTM D4024](#) or by hand lay-up process as per [ASTM D5421](#).

Preference shall be given to accessories produced by filament winding, since they have greater mechanical strength.

Accessories shall have at least the same chemical and mechanical properties (with respect to bursting, internal pressure, crushing, external pressure, load along a generating line and axial tension stresses) as the tubes on which they are intended to be fitted.

5.4 Various types of connections

Connections shall be made by cemented joints of the bell and spigot type, or by flanges, or butt-wrap lamination.

Butt-wrap laminated joints are not authorised, except in the case of networks having a pressure less than or equal to 5 bars conveying especially corrosive chemical fluids (case of use of polyester resins, paragraph 5.2.1), and for pipe-to-pipe connections only

Mechanical joints may be used (see paragraph 5.4.5).

The Manufacturer shall guarantee the same service pressure for the connections as for the tubes.

The dimensions of the connections are determined by the Manufacturer. Yet, for critical joints (as identified by as per [GS EP PVV 107](#), sections where stresses resulting from the computerized analysis exceed 85% Maximum allowable stress), reinforced inspection and supervision shall be applied. Critical joints are prohibited on site.

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The validity of the connections is proven by the tests called for in paragraph 6.

In the case of cemented joint adhesive bonding or of butt-wrap lamination, the assembly procedure shall be qualified according the requirements given in Appendix 1.

5.4.1 Cemented joints (bell and spigot type)

The Manufacturer must give a detailed description of the bonding method he recommends (for both shop and site fabrication).

He must supply all materials and equipment necessary, together with the following information concerning the adhesive:

- The curing time as a function of temperature
- Long-term variations in hardness after curing at various temperatures
- The time at which the piping system may be put into service.

There must be not gel-coat on the surface of the female part to be cemented.

Fittings fabricated by filament winding shall have female sockets at all ends ("bell" ends), except as otherwise indicated.

Fittings fabricated with glass strips may have only male ends ("spigots").

The Manufacturer shall indicate the dimensions of the male and female parts, together with the fabrication tolerances. He shall also indicate the shear stress on the glued surface at the service pressure, acting with full end thrust under pressure.

Socket connection parts must be delivered in a machined condition by the Manufacturer.

There are three types of bell and spigot connection, classified in decreasing order of preference:

- Cone to cone
- Male cylinder to female cone
- Cylinder-to-cylinder.

Preference shall be given to cone-to-cone connections.

Cylinder-to-cylinder connections are not allowed.

5.4.2 Laminated Joint

The Butt-wrap lamination consists of plain ended pipes prepared, aligned and laminated with Glass Fibers reinforcement and resin mix.

The outer pipe surface shall be abraded to remove the outer resin-rich surface and expose the reinforcing fibers over an area extending to at least 50 mm outside both ends of the laminate.

The bonding surface shall be clean and dry before starting any lamination activity. If the bonding surface is contaminated with oil or grease, it shall be cleaned using a clean cloth soaked in acetone or other suitable solvent. The cleaned surface shall not be touched or be contaminated by oil moisture prior to bonding. If the surfaces become contaminated or wet they shall be cleaned, re-ground and free of dust prior to starting the lamination.