

SPOOLABLE FIBRE-REINFORCED PLASTIC PIPES

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the use of spoolable fibre-reinforced plastic (FRP) pipe systems, both onshore and offshore. This DEP is limited to spoolable pipe made from thermoplastic lined fibre-reinforced thermosetting resins, so-called S-FRP and pipe made from fibre-reinforced thermoplastic resins, so-called S-RTP. Operating pressures are typically up to 300 bar, temperatures between –30 °C and 90 °C, diameters between 25 mm and 150 mm, and continuous length up to 10 km, depending on reel capacity.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorized by Shell GSI and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company and, where necessary, to Contractors and Manufacturers nominated by them.

This DEP is intended for use in oil refineries, chemical plants, gas plants, exploration and production facilities and, where applicable supply/marketing installations.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

1.3.1 General Definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates, and ultimately pays for, the project. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

design pressure

maximum internal pressure intended to be experienced by a component during its service life.

design temperature

for each design condition, maximum fluid temperature that can be reached during service.

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 rated pressure.

occasional load

maximum short-term duration load intended to be experienced during the component's service life.

operating pressure

normal or anticipated standard internal pressure to be experienced by a component which should not exceed the rated pressure, determined in accordance with this DEP.

pressure rating

rated pressure

maximum allowable continuous pressure, relating to its long-term resistance to failure when subjected to either static or cyclic internal pressure loading, determined in accordance with this DEP.

product family

component type all of whose variants have the same function.

product family representative

component that is taken to be representative of a particular **product family**.

product sector

subdivision of a product family that groups variants into specific diameter and pressure ranges.

product sector representative

component that has the highest nominal diameter and highest pressure rating in a particular sector.

qualification

process of demonstrating that a component is in accordance with the requirements of this DEP.

rated temperature

maximum allowable continuous temperature at the rated pressure determined in accordance with this DEP.

short term hydraulic burst strength

short term hydrostatic pressure strength

burst pressure measured during a short-term test.

tensile load rating

maximum allowable continuous tensile load, determined in accordance with this DEP.

1000 hour test

medium survival test to demonstrate long-term strength performance.

1.4 ABBREVIATIONS

GRE	Glass-fibre-reinforced epoxy
GRP	Glass reinforced plastic
NPR_s	Nominal pressure rating, static pressure service
NPR_c	Nominal pressure rating, cyclic pressure service
PA	Polyamide
PE	Polyethylene
PEX	Cross-linked polyethylene
PP	Polypropylene
PVC	Polyvinylchloride
PVDF	Polyvinylidenefluoride
P_{min}	Minimum pressure during pressure cycle

P_{max}	Maximum pressure during pressure cycle
R	Minimum / maximum pressure ratio during cyclic service
SLT	Standard laboratory temperature
S-FRP	Spoolable fibre-reinforced plastic
S-GRP	Spoolable glass-fibre-reinforced plastic
S-RTP	Spoolable reinforced thermoplastic
STHP	Short-term hydrostatic pressure strength
TLR	Tensile load rating
TP_{1000hrs}	Test pressure to be used in 1000-hour qualification test
TS	Tensile strength pipe
Tg	Glass transition temperature
UV	Ultraviolet

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documentations referenced in this DEP are listed in (9).

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards/DEP 31.40.10.20-Gen. folder. The DEP Administrator and DEP Author monitor these folders on a regular basis.

2. MATERIALS

2.1 GENERAL

The material selection process shall ensure that the material is compatible with the service fluids to which it is exposed over the full design temperature range so that the mechanical, physical and chemical properties of the structural wall satisfy the design requirements throughout the intended lifetime.

The materials selected shall be of a suitable commercial grade that complies with the technical requirements of the application.

The recommendations of the resin Suppliers for the use of hardeners, catalysts and accelerators shall be followed.

If specified by the Principal, the external pipe layer may be pigmented to provide suitable resistance to UV degradation effects and/or earthing requirements.

2.2 THERMOSET MATERIALS

Thermoset resins, typically used for the manufacture of fibre-reinforced pipe components, are epoxy, polyester, and vinyl ester. The resin shall have a glass transition temperature T_g of at least 30 °C above the rated temperature of the pipe component.

2.1.1 Polyester resins

Types of polyester resins, typically used for GRP pipe components, are:

- Isophthalic polyester. This is a relatively low cost resin, which is rarely used for chemical services. It is typically used in thermoplastic lined GRP pipe systems. The minimum glass transition temperature, T_g , is 90 °C;
- Bisphenol A polyester. This is a high temperature, chemically resistant resin that is extensively used in chemical service. It is a general-purpose resin and is easy to manufacture. The minimum glass transition temperature, T_g , is 120 °C;
- Chlorinated polyester. This resin has many of the properties of bisphenol A resins, but has an inherent fire retardant characteristic. This fire resistant property can be enhanced by addition of antimony oxide particles to the resin mix. The minimum glass transition temperature, T_g , is 110 °C.

2.1.2 Vinyl ester resins

Compared to polyester, vinyl ester resins have improved chemical resistance. High temperature resistant vinyl ester versions, e.g. Epoxy-Novolac, are also available. The minimum glass transition temperature, T_g , is 115 °C.

2.1.3 Epoxy resins

Epoxy resins are resistant to a wide range of moderately strong acids and alkalis, and most hydrocarbons. There are several types of base epoxy resins and associated curing agents.

Curing agents typically used for epoxy resin are:

- Aliphatic amine - Good resistance against caustics and solvents. Resistance against acids is fair. Minimum glass transition temperature, T_g , is 115 °C;
- Cyclo Aliphatic Amine – Excellent resistance against caustics and solvents. Resistance against acids is fair. Minimum glass transition temperature, T_g , is 140 °C;
- Aromatic Amine - Excellent resistance against caustics and solvents. Resistance against acids is fair. Minimum glass transition temperature, T_g , is 140 °C;
- Anhydride – Excellent resistance against acids. Resistance against caustics and solvents is poor. Minimum glass transition temperature, T_g , is 115 °C.