

GENERAL SPECIFICATION

CORROSION

GS EP COR 232

Composite/Syntactic foam used for buoyancy modules for permanent subsea applications

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1. Scope

This General Specification defines the minimum requirements for qualification, manufacture, testing and inspection of epoxy based composite/syntactic foam used for buoyancy modules for permanent subsea applications.

In case other matrix are used (wax; polyurethane etc.), a similar qualification process shall be used, with different safety factors if necessary. The specific qualification process shall be reviewed by Company for acceptance.

The maximum allowed operating temperature for the foam is set at +30°C.

It does not address the design of overall buoyancy function, which is part of the design of the system onto which it is clamped, nor the design and manufacturing of the clamping system.

[API SPEC 17L 1](#) and [API RP 17L 2](#) can be used for such purpose for flexible pipes.

[GS EP PLR 152](#) shall be used for hybrid riser systems.

[GS EP PLR 160](#) shall be used for subsea umbilicals.

[GS EP SPS 034](#) shall be used for well jumper design.

In all these cases above, the requirement for the qualification of the foam itself shall follow the requirement of this GS in case of conflicting requirements.

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
API RP 17L 2	Recommended Practice for Flexible Pipe Ancillary Equipment
API SPEC 16F	Specification for Marine Drilling Riser Equipment
API SPEC 17L 1	Specification for Flexible Pipe Ancillary Equipment
ASTM D2736	Hydrostatic compressive strength of rigid syntactic foam (Edition 1983)

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Reference	Title
GS EP PLR 152	Hybrid Riser Systems
GS EP PLR 160	Design, fabrication and testing of Subsea Umbilicals
GS EP SPS 034	Well Jumper Design

Abbreviations

IBL:	Instrumented Buoyancy Loss
HCP:	Hydrostatic Crush Pressure
PPT:	Pre Production Test
SF:	Syntactic Foam
ITP:	Inspection and Test Plan
PE:	Polyethylene
LLDPE:	Linear Low Density Polyethylene
MDPE:	Medium Density Polyethylene
HDPE:	High Density Polyethylene
CRA:	Corrosion Resistant Alloy
PQT:	Procedure Qualification Test
Tg:	Glass transition temperature

Definitions

Composite Foam:	mix of epoxy resin, glass microspheres and mini/macrospheres
Syntactic foam:	mix of epoxy resin and glass microspheres
Resin system:	epoxy binding agent for syntactic foam
Glass microspheres:	Hollow glass spheres with a diameter typically lower than 200 microns
Macrospheres:	Hollow spheres with a diameter higher than 5mm
Module:	pair of element
Element:	individual buoyancy part (i.e. poured in one mold)

3. Composite/syntactic foam qualification

3.1 General

The qualification process described here shall be understood as a one-off process and corresponds to a type certification up to a given water depth and foam type.

The Table 1 summarize the requirements for qualification testing:

Table 1 - Testing requirements for type qualification

Type reference	Type design water depth (m)	IBL testing pressure (b)	HCP testing pressure (b)
A	0-500	55	75
B	501-1000	110	150
C	1001-1500	165	225
D	1501-2000	220	300
E	2001-2500	275	375
F	2501-3000	330	450

Alternative ranges of water depth can be proposed for each type of composite foam (within a +/-20% margin) but with the same safety factors for IBL and HCP:

- IBL: 1.1 maximum type design water depth of the range
- HCP: 1.5 maximum type design water depth of the range.

The whole range up to 3000m does not need to be qualified at once for approval, but the qualified range shall include the expected design pressure of the subsea application.

The IBL testing shall be performed as per clause 3.3.1.

The HCP testing shall be performed as per clause 3.3.2.

The above qualification process shall be conducted for each type of resin system (cold or hot cure for instance).

It shall be conducted with or without external protective skin depending on whether or not the external skin plays a role in the overall design of the foam (in terms of IBL or HCP resistance for instance).

The qualification dossier shall be provided once available for review by Company. Once approved, it shall not be repeated unless significant changes in the manufacturing process or formulation of the foam. It shall include all the test results and requirements of clause 3.

All the testing below are done at 23°C+/-3°C. In case the foam is to be used at a temperature above this one and in the limit of 30°C max, a de-rating factor shall be proposed by the manufacturer to Company.

3.2 Raw materials

For all type qualifications, the following requirements shall be documented.

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3.2.1 Glass microspheres

For each batch, the following shall be obtained from the manufacturer:

- Name and address of manufacturer
- Product identification
- Manufacturing date (or alternatively, expiry date)
- Batch number
- Density (test result for each batch + acceptable range and testing standard)
- HCP (or alternatively the percentage of microspheres survivors when subjected to the target test pressure for the grade) (test results for each batch + acceptable range and testing standard).

3.2.2 Macrospheres

For each batch, the following shall be obtained from the manufacturer:

- Name and address of manufacturer
- Product identification
- Manufacturing date
- Batch number
- HCP (test results for each batch + acceptable range and testing standard)-testing shall be done on a ten (10) macrospheres sampling size loaded in pressure and the HCP result shall be the collapse of the first macrosphere. 3 tests per batch. Pressure rate: 3 bars/seconds maximum.
- Glass transition temperature (test results for each batch + acceptable range and testing standard)
- Density (test results for each batch + acceptable range and testing standard).

The HCP shall also comply with Table 1 requirements for HCP (similar requirement than the composite/syntactic foam) if by design, the external skin does not play a role in the overall design of the foam.

For design and qualification purpose, the HCP result shall be higher than 1.5 the maximum design pressure.

If the external skin contributes to the hydrostatic and buoyancy loss resistance of the foam, the macrospheres can be rated with a lower safety factor provided it can be demonstrated by the manufacturer via a specific qualification dossier to be submitted for Company approval.

In addition, the HCP minimum value shall be proposed by the material manufacturer for QA/QC purpose during PPT and production and come from the intrinsic properties of the macrospheres as tested for each batch above.