PAS 1008:2016

Specification for the performance and testing of a single-use flexitank

CONTAINER OWNERS ASSOCIATION

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Publishing and copyright information

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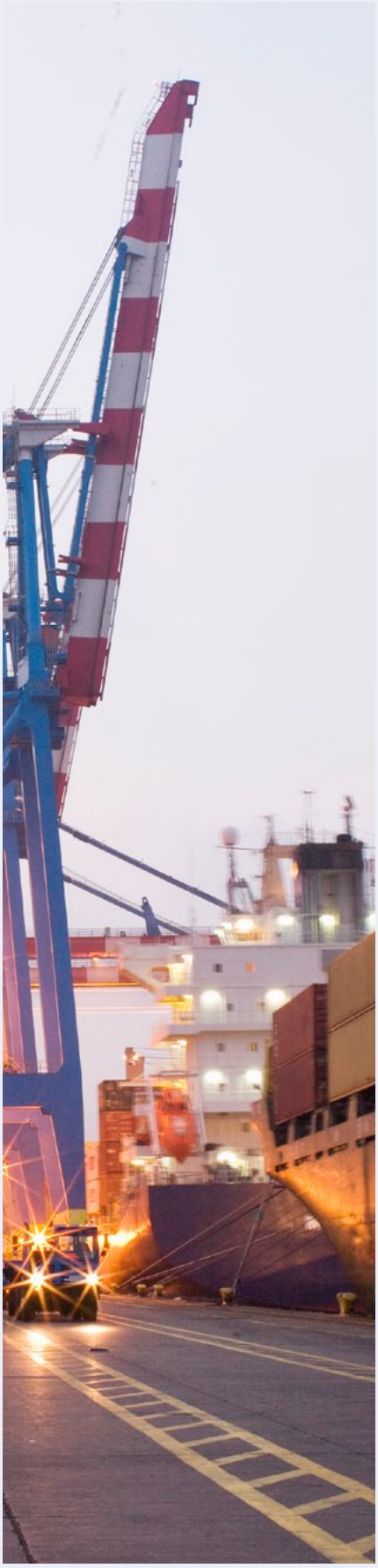

Foreword

This PAS was commissioned by the Container Owners Association (COA) on behalf of a group of flexitank companies. Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 30 September 2016.

Acknowledgement is given to Andrew Sangster and Sergio Parenzee of the COA Flexitank Division, as the technical authors, and the following organizations that were involved in the development of this PAS as members of the steering group:

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- Sun Flexitanks
- Trans Ocean Bulk Logistics/Hillebrand Group

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PAS process enables a specification to be rapidly developed in order to fulfil an immediate need in industry. A PAS may be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Supersession

PAS 1008:2016 supersedes PAS 1008:2014, which is withdrawn.

Information about this document

Product certification/inspection/testing. Users of this PAS are advised to consider the desirability of third-party certification/inspection/testing of product conformity with this PAS. Users seeking assistance in identifying appropriate conformity assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Assessed capability. Users of this PAS are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Test laboratory accreditation. Users of this PAS are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this PAS are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in italic type, and does not constitute a normative element.

Requirements in this standard are drafted in accordance with *The BSI guide to standardization – Section 2: Rules for the structure, drafting and presentation of British Standards*, subclause **J.1.1**, which states, "Requirements should be expressed using wording such as: 'When tested as described in Annex A, the product shall ...'". This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS cannot confer immunity from legal obligations.

0 Introduction

0.1 What is a flexitank?

A flexitank is a large bladder with valve(s) that is designed to fit inside a general purpose (GP) freight container [1)] and is used for the transport of liquids that are not classified or regulated as dangerous goods. Flexitanks can be constructed from polyethylene, polyethylene blends and polyvinyl chloride (PVC), but other materials can also be used.

0.2 What is a flexitank system?

While a flexitank is a single entity, it operates as part of a system which includes the flexitank, its fittings, restraining system, if used and constraining equipment, if used, and a GP freight container.

NOTE *The GP freight containers used are usually standard dry 20 ft (6 m) units, but other sizes can also be used.*

0.3 Objective of PAS 1008

The main objective of PAS 1008 is to provide a framework for the manufacture of flexitanks to a high quality, such that they can be used to transport liquids safely without leaking and without causing permanent damage to the GP freight container.

This is achieved through setting minimum requirements for:

a) the material properties of the flexitank film and, where fitted, the sleeve;

b) the leak tightness of the loading/discharging valve(s);

c) the flexitank system's resistance to an impact.

The performance of the flexitank system is assessed by means of a rail impact test. Material testing is performed to demonstrate that minimum requirements for the material properties are met and maintained, and that the material specification is the same as assessed in the rail impact test. Valve testing is undertaken to demonstrate that the valve is able to withstand operating pressures without leaking.

0.4 Using PAS 1008

PAS 1008 is for use by flexitank manufacturers in the manufacture and testing of flexitanks.

The following parties will also benefit from the outcomes of this PAS:

- shippers and cargo owners;
- flexitank operators;
- haulage companies;
- forwarders and non-vessel owning freight container operators;
- shipping lines;
- rail operators;
- freight container leasing companies;
- insurance companies and protection and indemnity (P&I) clubs;
- the general public.

[1)] A "GP freight container" is also known as a "shipping container", "standard container", "dry cargo container", "ISO container", "cargo container", among others.

1 Scope

This PAS specifies requirements for a single-use flexitank used for the intermodal transport of a liquid commodity (that is not classified or regulated as dangerous goods) in a general purpose (GP) freight container. It is applicable to single-layer and multilayer flexitanks made from polyethylene [2)], polyethylene blends and polyvinyl chloride (PVC). It is applicable to flexitanks capable of carrying a commodity with a maximum mass of ≤24 000 kg and with a maximum volume of ≤24 000 L.

It specifies requirements for:

a) the material properties of the flexitank film and, where fitted, the sleeve;
b) the leak tightness of the loading/discharging valve(s);
c) the flexitank system's resistance to a rail impact defined as a 2*g* (gravitational unit) retardation or acceleration force;
d) the provision of flexitank information.

It describes a method for testing the leak tightness of the loading/discharging valve(s).

It also describes a method of determining the flexitank's suitability for intermodal transport by means of a rail impact test of the flexitank when installed in a GP freight container together with its restraining system.

This PAS does not cover requirements or test methods for multi-use flexitanks or flexitanks used for storage.

This PAS only covers flexitanks for use in GP freight containers and not those used in other types of freight containers, such as reefers.

This PAS does not cover compatibility testing of the commodity with the flexitank film.

NOTE 1 *The flexitank manufacturer might need to carry out compatibility testing to determine whether a flexitank is suitable for carrying a specific commodity. The compatibility of the flexitank and commodity depends on the chemical and physical properties of both the flexitank film and the commodity.*

This PAS does not provide guidance on the operation (i.e. the installation, loading, transport, discharge and disposal) of a flexitank.

NOTE 2 *Recommendations on the operation of the flexitank system are given in COA's publication,* Code of Practice for Flexitanks *[1].*

[2)] Polyethylene encompasses polythene.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM D751, *Standard test methods for coated fabrics*

ASTM D882, *Standard test method for tensile properties of thin plastic sheeting*

ASTM D1004, *Standard test method for tear resistance (graves tear) of plastic film and sheeting*

ASTM D1709-09, *Standard test methods for impact resistance of plastic films by free falling dart method (Method A)*

ASTM D4595, *Standard test method for tensile properties of geotextiles by the wide-width strip method*

ASTM D4833/D4833M, *Standard test method for index puncture resistance of geomembranes and related products*

ASTM D5035, *Standard test method for breaking force and elongation of textile fabrics (strip method)*

ASTM D5199, *Standard test method for measuring the nominal thickness of geosynthetics*

ASTM D5602/D5602M, *Standard test method for static puncture resistance of roofing membrane specimens*

ASTM D6392, *Standard test method for determining the integrity of nonreinforced geomembrane seams produced using thermo-fusion methods*

ASTM D6693/D6693M, *Standard test method for determining tensile properties of nonreinforced polyethylene and nonreinforced flexible polypropylene geomembranes*

ASTM D6988, *Standard guide for determination of thickness of plastic film test specimens*

BS 3951-1.2, ISO 1161, *Freight containers – Part 1: General – Section 1.2 Specification for corner fittings for series 1 freight containers*

BS EN ISO 2411, *Rubber or plastics-coated fabrics – Determination of coating adhesion*

BS EN ISO 13934-1, *Textiles – Tensile properties of fabrics – Part 1: Determination of maximum force and elongation at maximum force using the strip method*

BS ISO 668:2013+A2:2016, *Series 1 Freight containers – Classification, dimensions and ratings*

BS ISO 1496-1, *Series 1 Freight containers – Specification and testing of series 1 freight containers – Part 1: General cargo containers for general purposes*

3 Terms and definitions

For the purposes of this PAS, the following terms and definitions apply.

3.1 bonnet cavity

void above the seals or disc of a gate valve

3.2 commodity

liquid cargo carried inside the flexitank

3.3 commodity loading temperature

temperature of the commodity at which it is loaded into the flexitank and measured at the closest upstream point possible to the load/discharge valve on the flexitank

3.4 constraining equipment

structure that is used to reduce the pressure of the flexitank on the GP freight container walls

***NOTE** Examples of constraining equipment include reinforcing bars at front end wall and side walls and boards or materials other than freight container lining.*

3.5 crystalline melting point (T_m)

temperature at which crystalline or semi-crystalline polymers undergo a transition from a crystalline phase to an amorphous phase and lose mechanical integrity

3.6 flexitank

bladder with a loading/discharging valve which is installed inside a GP freight container as part of a flexitank system and is used for holding the commodity

***NOTE 1** The flexitank is usually constructed from polyethylene [3] and polyethylene blends, but other materials (such as PVC) can also be used.*

***NOTE 2** Other equipment is necessary for the filling and discharge of liquids from the flexitank, such as pumps and hoses.*

3.7 fitting

functional device attached to and forming an integral part of the flexitank system

***NOTE** Examples of fittings include valves, pressure release devices, valve housings and attachments.*

3.8 flexitank system

system used for the transport of a liquid commodity, which comprises a flexitank, a restraining system, if used, constraining equipment, if used, and a GP freight container

3.9 freight container lining

layer or layers of material used on the inside of a GP freight container to protect a flexitank from foreign object damage

***NOTE** Typically, the material used is plastic or cardboard.*

3.10 general purpose (GP) freight container

steel rectangular box structure used for the transport of general cargo

3.11 geomembrane

impermeable membrane usually manufactured from polyethylene as the primary parent ingredient and used to contain liquids by blocking liquid migration across the membrane

***NOTE** Typically, the geomembrane thicknesses for flexitanks range from 0.5 mm to 1.1 mm.*

3.12 glass transition temperature (T_g)

temperature at which amorphous polymers or amorphous areas of semi-crystalline plastics undergo a transition from a rubbery, viscous state, to a brittle, glassy amorphous solid and lose flexural properties

[3] Polyethylene encompasses polythene.

3.13 intermodal transport

movement of goods in one and the same cargo transport unit (freight container), which uses successively two or more modes of transport without handling the goods themselves in changing modes

[SOURCE: *Terminology on combined transport [2]*, adapted]

3.14 multilayer flexitank

flexitank consisting of multiple layers of polymeric films welded closed at each end, with one or more closure seams per layer and sheathed in a sleeve

***NOTE** For definition of single-layer flexitank, see **3.18**. For definition of sleeve, see **3.19**.*

3.15 obturator

part of a valve, such as a ball, clapper, disc, gate or plug, that is positioned in the flow stream to permit or prevent flow

[SOURCE: ISO 14313]

3.16 restraining system

structure that is used to prevent the flexitank from making contact with the doors of the GP freight container

***NOTE** An example of a restraining system is a steel frame bulkhead or structure secured into the rear corner post vertical recesses.*

3.17 PVC-coated woven fabric film

woven fabric mesh substrate, usually made from polyester or nylon, coated with a PVC layer on both sides of the fabric

3.18 single-layer flexitank

flexitank consisting of a layer of geomembrane film welded closed at each end, with one or more closure welds and can be sheathed in a sleeve for additional strength

***NOTE** For definition of multilayer flexitank, see **3.14**. For definition of sleeve, see **3.19**.*

3.19 sleeve

structural layer fitted to a flexitank that provides additional multi-axial structural strength to the flexitank

***NOTE 1** A sleeve is the structural element of all multilayer flexitanks and is an optional element for a single-layer flexitank.*

***NOTE 2** The sleeve can be mechanically attached to the flexitank or it can rely solely on friction between itself and the flexitank layers to remain in position when the flexitank is full.*

***NOTE 3** For multilayer flexitanks, the sleeve is closed at both ends and it totally encloses the flexitank. For a single-layer flexitank the sleeve can either totally or partially enclose the flexitank.*

4 Materials

4.1 Single-layer flexitank consisting of polyethylene/polyethylene blend film with or without sleeve

When tested in accordance with the test standards specified in Table 1, the material properties of the flexitank film and, where fitted, the sleeve shall meet the minimum requirements as specified in Table 1.

Table 1 – Material tests for polyethylene/polyethylene blend film and, where fitted, sleeve material used in a single-layer flexitank

Material property		Parameter	Test standard	Requirement for material property
Single layer: Polyethylene/polyethylene blend				
1	Puncture resistance	Film with a thickness of ≥0.5 mm to ≤1.5 mm	ASTM D4833/ D4833M	≥260 N
2	Tensile break strength and elongation	Film with a thickness of >0.25 mm	ASTM D6693/ D6693M	≥23 N·mm $^{-1}$ and ≥600% (MD and TD)
3	Weld strength	All welds in peel and shear	ASTM D6392	≥90% of yield strength of the recorded parent film's yield strength when tested to ASTM D6693/D6693M The seal shall elongate at least 20 mm before failure
4	Tear resistance	Film with a thickness of ≤1.5 mm	ASTM D1004	75 N (MD and TD)
5	Thickness	Film with a thickness of ≥0.5 mm to ≤1.5 mm	ASTM D5199	Average thickness ±5% nominal, ±15% maximum spot measurement Measure every 200 mm around the complete circumference of the film
Sleeve, where fitted				
A	Ultimate tensile strength and elongation	Material with a fabric weight ≥150g·m^{-2}	ASTM D4595 [A)] or ASTM D5035 or BS EN ISO 13934-1	≥1 400 N/50 mm ultimate tensile strength warp and weft (for ASTM D4595 and ASTM D5035) or ≥140 kg (for BS EN ISO 13934-1)
			ASTM D4595 or ASTM D5035 or BS EN ISO 13934-1	≥15% elongation warp and weft
B	Stitch strength	Material with a fabric weight ≥150g·m^{-2}	ASTM D4595 [A)] or ASTM D5035	≥500 N/50 mm

NOTE 1 *For each test, a new material sample is used.*

NOTE 2 *MD = machine direction; TD = transverse direction*

[A)] The ASTM D4595 and ASTM D5035 test methods do not cover the securing method of the loose thread ends when preparing the test specimen. It is common practice to secure the loose thread ends with a knot.

4.2 Multilayer flexitank consisting of polyethylene/polyethylene blend film with a sleeve

When tested in accordance with the test standards specified in Table 2, the material properties of each flexitank film and the sleeve shall meet the minimum requirements as specified in Table 2.

Table 2 – Material tests for polyethylene/polyethylene blend film and sleeve material used in a multilayer flexitank

Material property		Parameter	Test standard	Requirement for material property
Inner layers: Polyethylene/polyethylene blend				
1	Impact strength [A)]	Film with a thickness of ≤0.5 mm	ASTM D1709-09, Method A	total impact strength of combined film layers of ≥2 250 g ***NOTE*** *For example, if the cumulative total thickness of all layers is 375 µm then the average strength required is 6 g·µm^{-1}.*
2	Ultimate tensile strength and elongation	Film with a thickness of ≤0.5 mm	ASTM D882	≥26.0 N·mm^{-2} and ≥600% elongation (MD and TD)
3	Seal strength	Film with a thickness of ≤0.5 mm and a single seal of the liquid contact layer	ASTM D882	≥100% of yield strength of the recorded parent film's yield strength when tested to ASTM D882
4	Thickness	Film with a thickness of ≤0.5 mm	ASTM D6988	Average thickness ±5% nominal, ±15% maximum spot measurement Measure every 200 mm around the complete circumference of the film
Sleeve				
A	Ultimate tensile strength and elongation	Material with a fabric weight ≥150g·m^{-2}	ASTM D4595 or ASTM D5035 or BS EN ISO 13934-1	≥1 400 N/50 mm ultimate tensile strength warp and weft (for ASTM D4595 or ASTM D5035) ≥140 kg (for BS EN ISO 13934-1)
			ASTM D4595 or ASTM D5035 or BS EN ISO 13934-1	≥15% elongation warp and weft
B	Stitch strength	Material with a fabric weight ≥150g·m^{-2}	ASTM D4595 [B)] or ASTM D5035	≥500 N/50 mm

NOTE 1 *For seal strength, the thickness of the flexitank film layer in contact with the product should be measured and used to calculate the seal area.*

NOTE 2 *For each test, a new material sample is used.*

NOTE 3 *MD = machine direction; TD = transverse direction*

[A)] For impact strength, each flexitank film layer should be tested individually and the total impact strength of the combined film layers should be calculated as the sum of the individual film layer impact strengths.

[B)] The ASTM D4595 and ASTM D5035 test methods do not cover the securing method of the loose thread ends when preparing the test specimen. It is common practice to secure the loose thread ends with a knot.

4.3 Single-layer flexitank consisting of PVC-coated woven fabric film

When tested in accordance with the test standards specified in Table 3, the material properties of the PVC-coated woven fabric film shall meet the requirements as specified in Table 3.

Table 3 – Materials tests for PVC-coated woven fabric film used in a single-layer flexitank

Material property		Test parameter	Test standard	Minimum requirement for material property
1	Static puncture resistance	—	ASTM D5602/ D5602M	≥15 kg
2	Adhesion of coating to fabric	—	BS EN ISO 2411	≥40 N/25 mm
3	Seal strength	—	ASTM D751, all methods	≥75% of material breaking strength
4	Weight of coating and fabric	—	ASTM D751	≥550 $g \cdot m^{-2}$
5	Tensile strength and elongation	—	ASTM D751	≥33 $kN \cdot m^{-1}$ breaking force in any direction ≥20% elongation at break
6	Tear resistance	—	ASTM D751	≥200 N in any direction
7	Thickness	—	ASTM D751	±7.5% including scrim Spot to spot thickness ±15%

NOTE 1 *The material tests are conducted independently of one another and on different samples of flexitank film.*

NOTE 2 *PVC-coated fabric material is typically coated both sides and the base fabric is polyester or nylon weave.*

5 Loading and discharging valves

NOTE 1 *This clause covers loading and discharging valves only, i.e. it does not cover pressure release valves.*

When the loading and discharging valve is tested for leakage in accordance with Annex A:

a) if the test fluid is a liquid, there shall be no visually detectable leakage of fluid from the valve;

b) if the test fluid is a gas, there shall be:

1) no bubbles breaking the surface of the water, when the valve is immersed in water;

2) no continuous formation of bubbles, when the valve is coated with a leak detection fluid.

NOTE 2 *In addition to the leak tightness test at Annex A, the flexitank manufacturer should conduct an additional leak tightness check of the valve when assembling the flexitank system.*

6 Flexitank system

When the flexitank system is tested for performance in accordance with Annex B, the following requirements shall be met.

a) There shall be no visually detectable leakage from the flexitank.

b) The flexitank and restraining system, if used shall not be in contact or make contact with the interior of the GP freight container doors at any time during the test.

c) Any fitted valve shall not be in contact or make contact with the interior of the walls, doors or roof of the GP freight container at any time during the test.

d) Before discharge of the water, the deformations of the GP freight container after each impact at each measurement point as specified in Figure 1 for the end wall and Figure 2 for the side walls shall not exceed the values specified in Table 4.

Table 4 – Maximum deformations of the GP freight container at any measurement point after filling with water and after each impact

Area of the GP freight container	Maximum deformation mm
End wall	40
Side walls	40
NOTE *The deformation values represent the maximum permitted deformation measured at each of the measurement points as specified in Figure 1 (p.9) and Figure 2 (p.9).*	

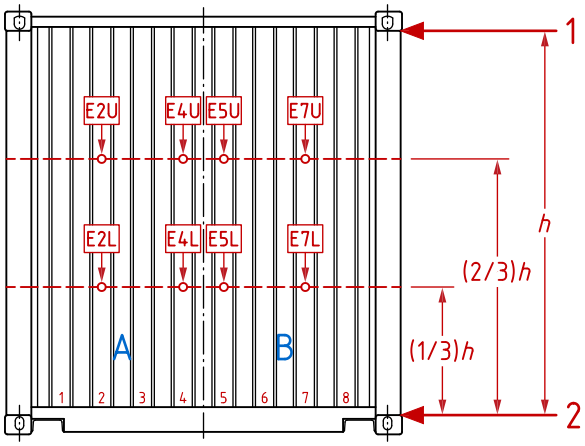
e) After discharge of the water, the deformations of the GP freight container at each measurement point as specified in Figure 1 for the end wall and Figure 2 for the side walls shall not exceed the values specified in Table 5.

NOTE *The maximum permitted permanent/residual deformations of the GP freight container are in line with those specified in BS ISO/TR 15070.*

Table 5 – Maximum permanent deformations of the GP freight container at any measurement point after discharge of the water

Area of the GP freight container	Maximum deformation mm
End wall	7
Side walls	8
NOTE 1 *The deformation values represent the maximum permitted permanent deformation measured at each of the measurement points as specified in Figure 1 (p.9) and Figure 2 (p.9).* ***NOTE 2*** *The maximum permitted permanent/residual deformations of the GP freight container are in line with those specified in BS ISO/TR 15070.*	

Figure 1 – End wall: Location of measurement points at which the deformation of the GP freight container is assessed



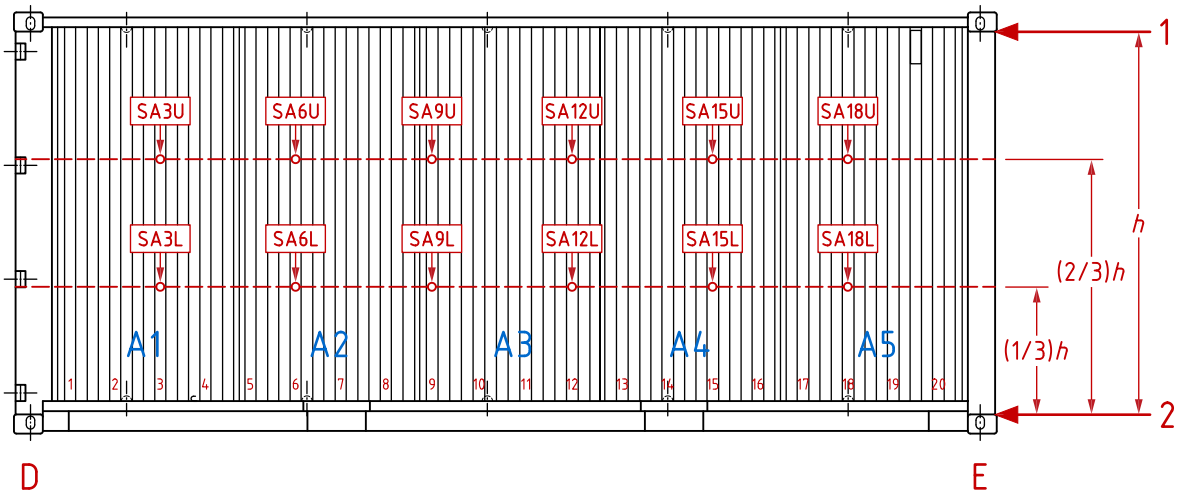
The end wall measure points shall be located at the 2nd, 4th, 5th and 7th outboard corrugations starting from the left-hand vertical corner post to the right-hand vertical corner post at 1/3*h* and 2/3*h*.

NOTE *A total of 8 end wall measurements are taken.*

Key

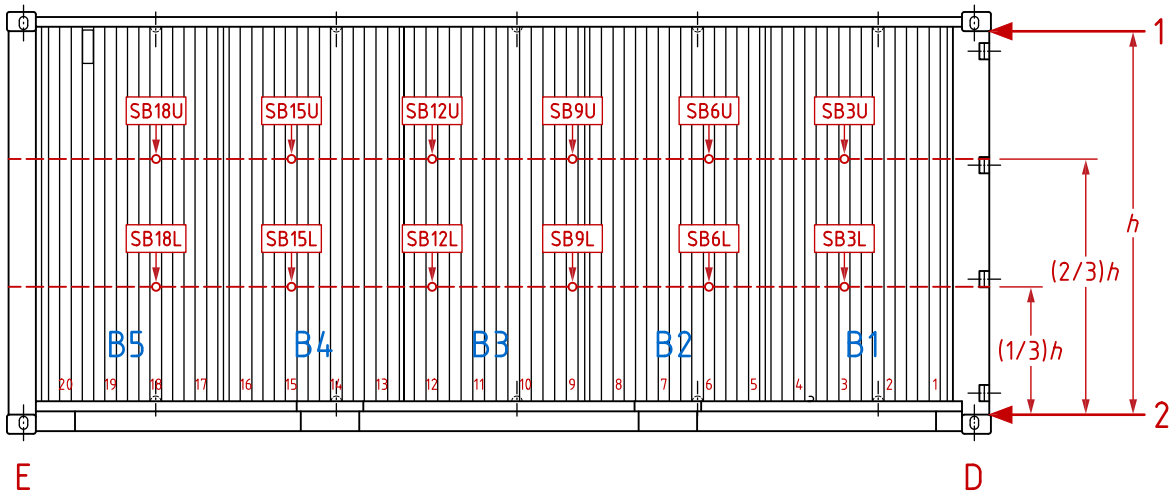
h	Effective height
	Measurement point and label
	NOTE *The labelling system comprises E = end wall, U = upper, L = lower and 2, 4, 5, 7 = numbered outboard corrugations.*
1	Lower edge of the upper corner casting
2	Top edge of the lower corner casting
A	Left-hand panel (when viewed from door end of the GP freight container)
B	Right-hand panel (when viewed from door end of the GP freight container)

Figure 2 – Side wall: Location of measurement points at which the deformation of the GP freight container is assessed



a) Side wall A – Right-hand side when facing doors

Figure 2 – Side wall: Location of measurement points at which the deformation of the GP freight container is assessed *(continued)*



b) Side wall B – Left-hand side when facing doors

The side wall, right-hand, measurement points shall be located every 3rd outboard corrugation starting from the door to the end wall at 1/3*h* and 2/3*h*.

The side wall, left-hand, measurement points shall be located every 3rd outboard corrugation starting from the end wall to the door at 1/3*h* and 2/3*h*.

NOTE *For a 20 ft GP freight container, a total of 12 side wall measurements are taken for each side wall, 6 at each height level; the first horizontal measurement is taken at the 3rd outboard corrugation, the second measurement at the 6th outboard corrugation, etc. and the final measurement is taken at the 18th outboard corrugation. For a 40 ft GP freight container, a total of 26 measurements are taken for each side wall, 13 at each height level; first horizontal measurement is taken at the 3rd outboard corrugation, the second measurement at the 6th outboard corrugation, etc. and the final measurement is taken at the 39th outboard corrugation.*

Key

h	Effective height
	Measurement point and label ***NOTE*** *The labelling system comprises SA = side wall A, SB = side wall B, U = upper, L = lower and 3, 6, 9, 12, 15, 18 = numbered outboard corrugations.*
1	Lower horizontal plane of the upper corner casting
2	Higher horizontal plane of the lower corner casting
A1 to A5	Side panel sections right-hand side
B1 to B5	Side panel sections left-hand side
D	Door
E	End wall

7 Commodity loading temperature range

The commodity loading temperature range shall be calculated from the material properties of the flexitank film as:

a) highest temperature of range: at least 20 °C below the crystalline melting point (T_m) of either the flexitank film or the loading and discharging valve, whichever is the lower temperature; and

b) lowest temperature of range: at least 20 °C above the glass transition temperature (T_g) of either the flexitank film or the loading and discharging valve, whichever is the higher temperature.

NOTE *For example, if the* T_m *of the flexitank film is 100 °C and of the loading and discharging valve is 85 °C, the highest temperature of the commodity at loading would be 65 °C; if the* T_g *of the flexitank film is 0 °C and of the loading and discharging valve is -10 °C, the lowest temperature of the commodity at loading would be 20 °C. The commodity loading temperature range would be given as 20 °C to 65 °C.*

8 Flexitank system information

The following information shall be available for each flexitank:

a) reference to this PAS, i.e. "PAS 1008:2016";

b) manufacturer's name and address;

c) testing facility's name and address;

d) where obtained, certification mark;

e) reference to the tests carried out and to which test standard:

   1) for a single-layer flexitank: puncture resistance, weld strength, tensile break strength and elongation, tear resistance and thickness tests (see **4.1**);

   2) for a multilayer flexitank: impact strength, seal strength, ultimate tensile strength and elongation, and thickness tests (see **4.2**);

   3) for the sleeves of a single-layer flexitank: ultimate tensile strength and elongation and stitch strength tests (see **4.1**);

   4) for the sleeves of a multilayer flexitank: ultimate tensile strength and elongation and stitch strength tests (see **4.2**);

   5) valve leakage test (see Annex A);

   6) rail impact test (see Annex B);

f) flexitank capacity (in L);

g) type and size of the GP freight container used in the rail impact test (see **B.2.1**);

h) the specification and assembly drawing of the restraining system that was used in the rail impact test (see **B.3.7**) and to be supplied as part of the flexitank system;

i) operating manual covering at a minimum fitting of the flexitank system, loading and discharging, commodity loading temperature range (see Clause **7**), storage instructions, instructions to refer to the manufacturer for storage life;

j) recycling code for the flexitank and restraining system.

9 Marking

9.1 All flexitanks shall be marked with the following information:

a) reference to this PAS, i.e. "PAS 1008:2016" [4];
b) the manufacturer's name and/or recognized logo;
c) a unique flexitank serial number;
d) flexitank capacity (in L).

9.2 Markings shall be located on the flexitank, such that when fitted within a GP freight container, it is visible when the right-hand door of the GP freight container is open.

10 Documentation

The test data shall be retained for a minimum of 6 years from the date of manufacture.

NOTE *The flexitank manufacturer should provide their test data to the COA.*

11 Incident records

The flexitank manufacturer shall keep records of reported incidents involving their flexitanks. These records shall include:

a) the unique flexitank serial number;
b) capacity of the flexitank (in L);
c) date of incident;
d) location of incident;
e) type of incident;
f) quantity of commodity lost (in L);
g) commodity;
h) volume and mass of commodity loaded;
i) restraining system;
j) root cause or possible root causes;
k) photographs of the incident including any damage to the flexitank and the shipping container.

NOTE *The incident records should be used for improving the flexitank system as part of a process of continuous development and for auditing and insurance purposes.*

[4] Marking PAS 1008:2016 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Annex A (normative)
Test method for leak tightness of valves

NOTE 1 *This test method is for use in checking the leak tightness of a valve.*

NOTE 2 *This test method is based on the test method for leak tightness for valves as described in BS EN 12266-1:2012, test reference P12, and can be used for testing all types of valves of any material.*

A.1 Principle

A valve is submitted to a pressure for a defined duration to assess whether it leaks.

A.2 Test equipment

A.2.1 General

The test equipment shall be of such a design that it does not subject the valve to externally applied loads which might affect the results of the test.

NOTE *The test equipment can apply external loads sufficient to react to the forces resulting from the test pressure.*

A.2.2 Measuring equipment

The measuring equipment shall be capable of measuring fluid pressure with an accuracy of ±5% of the required test pressure.

A.2.3 Test fluid

A.2.3.1 The test fluid to be used shall be:

a) either a liquid (water which may contain a corrosion inhibitor, or any other suitable liquid having a viscosity not greater than water); or

b) a gas (air or other suitable gas).

A.2.3.2 The test fluid temperature shall be between 5 °C and 40 °C.

A.3 Test specimen

The test specimen shall comprise a loading/discharging valve used as part of a flexitank system.

NOTE *The loading/discharging valve is tested independently of the flexitank.*

A.4 Test procedure

A.4.1 General

The test procedure to be used shall be in accordance with Table A.1 selected by type of valve.

NOTE *Ball valves and butterfly valves are the most common valves used in the flexitank system.*

A.4.2 Test pressure

The test pressure shall be a minimum of (0.5 ± 0.1) bar [5)].

A.4.3 Test duration

The test duration shall be 30 s.

A.5 Test report

The test report shall include the following information as a minimum:

a) reference to this test method (i.e. PAS 1008:2016, Annex A);

b) valve type;

c) date of test;

d) name of tester;

e) test pressure;

f) test duration;

g) visually detectable leakage (yes/no);

h) unique identifier of valve tested.

NOTE *A test report may include the test results of more than one valve.*

[5)] 1 bar = 100 kPa.

Table A.1 – Leak tightness test method

Type of valve		Test procedure
1	Ball valve Gate valve Plug valve A), B), C), D), E)	a) Fill the valve cavity including if present, the bonnet cavity with the test fluid (**A.2.3**). b) Move the obturator to the closed position using a force in accordance with the valve manufacturer's instructions. c) Apply the test pressure specified in **A.4.2** and maintain the test pressure for the test duration specified in **A.4.3**. d) Determine whether there is any visually detectable leakage during the test. F)
2	Globe valve	a) Fill the upstream valve cavity with the test fluid (**A.2.3**). b) Move the obturator to the closed position. c) Apply the test pressure specified in **A.4.2** in the direction to unseat the obturator, and maintain the test pressure for the test duration specified in **A.4.3**. d) Determine whether there is any visually detectable leakage during the test. F)
3	Diaphragm valve	a) Fill the valve cavity with the test fluid. b) Move the obturator to the closed position. c) Apply the test pressure specified in **A.4.2** in the flow direction marked on the body, and maintain the test pressure for the test duration specified in **A.4.3**. d) Determine whether there is any visually detectable leakage during the test. F)
4	Butterfly valve G)	a) Fill the valve cavity with the test fluid (**A.2.3**). b) Move the obturator to the closed position. c) Apply the test pressure specified in **A.4.2** to the disc in the marked direction or in the direction upstream of the disc (as this produces the most adverse sealing condition) and maintain the test pressure for the test duration specified in **A.4.3**. d) Test double disc butterfly valves either in both directions with the body vent plug removed, or test by introducing the test pressure between the discs via a shell tapping and measuring leakage either side of the disc. e) Determine whether there is any visually detectable leakage during the test. F)

A) The procedure described might not ensure pressurization of the integrate space of double-seated valves and might not therefore permit verification of the leakage rate of the downstream seat. When such pressurization is a requirement of the product or performance standard, or is required by the purchaser, it may be necessary to move the obturator to the closed position before applying the force of closing.

B) Valves which incorporate "double block and bleed" design features shall have the bleed plug removed prior to the test in order to prove the "double block and bleed" capability.

C) Valves with double sealing (such as two-piece obturator or double-seated valves) could be tested by applying the test pressure between the seats and checking each side of the closed valve.

D) Soft seated ball valves previously subjected to a liquid seat test pressure may have a reduced performance capability in some subsequent services at low differential pressures. If a liquid seat test pressure is specified and is carried out before a low pressure gas seat test, it might be necessary to allow time for the seat material to recover.

E) With plug valves relying on a sealing compound to effect a seal, the valve may be charged with sealing compound prior to testing.

F) "No visually detectable leakage" means no visible weeping or formation of drops or bubbles. If leakage rate measurements are carried out by automatics means, this should be qualified by the manufacturer's quality system.

G) Valves with symmetrical seating may be tested in either direction.

Annex B (normative)
Flexitank system rail impact test

B.1 Principle

The rail impact testing aims to demonstrate the performance of the flexitank systems when subjected to at least two 2*g* longitudinal impacts.

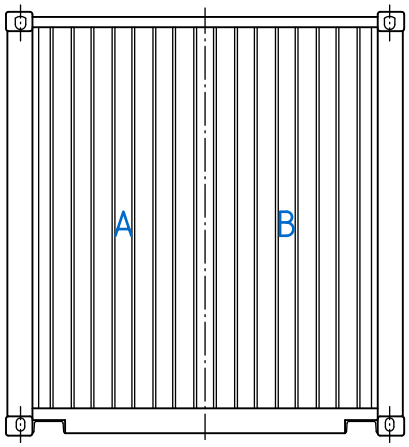
B.2 Test apparatus

B.2.1 Test container, comprising a (used) GP freight container conforming to BS ISO 1496-1. GP freight containers conforming to BS ISO 668 shall be rated as 30 480 kg in accordance with BS ISO 668:2013, Table 2, for a 20 ft test container. 40 ft test containers shall be rated as 32 000 kg.

NOTE 1 *Figure B.1 to Figure B.4 show test container panel sections and door posts.*

NOTE 2 *In reference to Figure B.1 to Figure B.4: Each individual panel section is designated by an alpha-numeric string, where A = side wall A, B = side wall B and 1 to 5 (for a 20 ft test container) and 1 to 11 (for a 40 ft test container) = panel numbering from door to end wall. Collectively, these individual panels are welded together vertically to make up a complete side wall or end (front) wall assembly. For example, panel sections A1, A2, A3, A4 and A5 make up the right-hand side wall assembly of a 20 ft test container.*

Figure B.1 – End wall: Panel sections

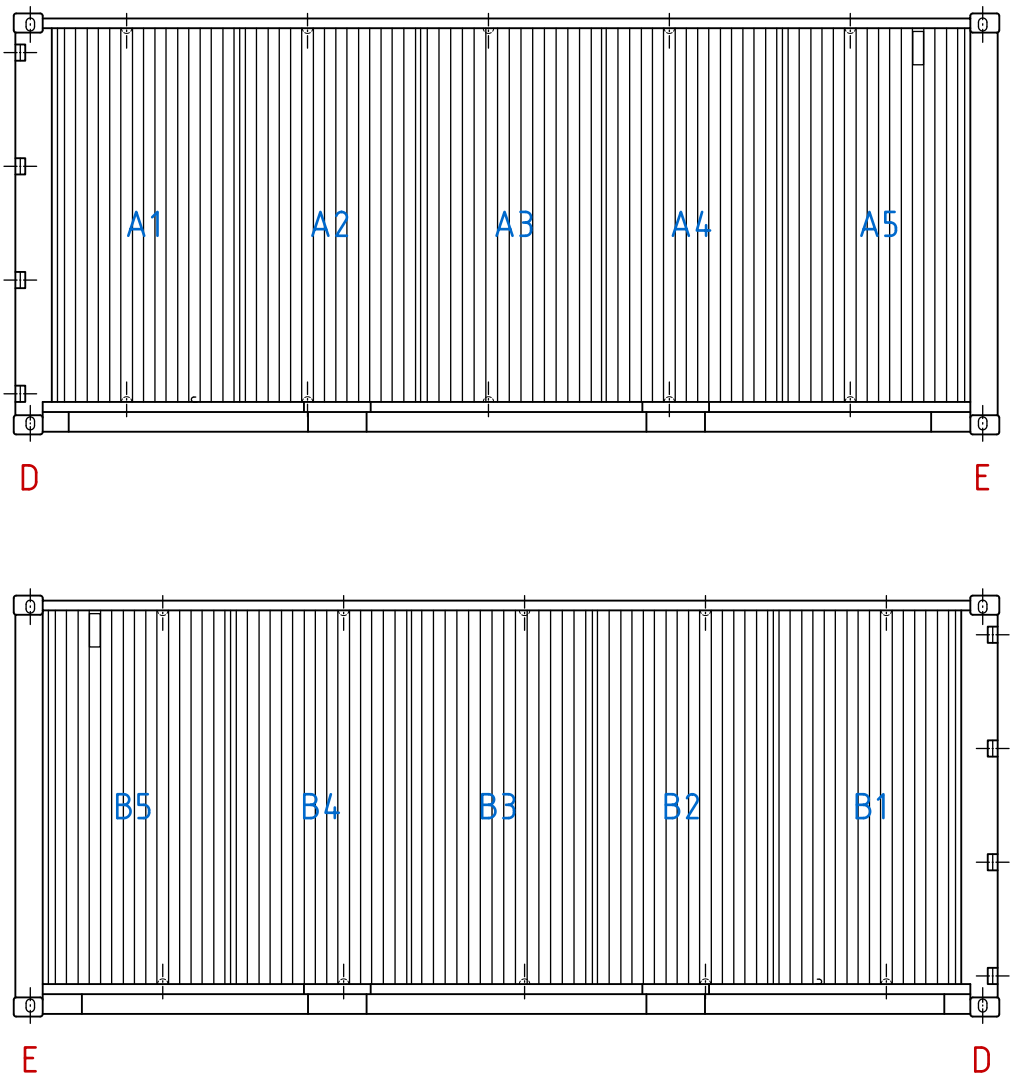


Key

A Left-hand panel (when viewed from door end of the GP freight container)

B Right-hand panel (when viewed from door end of the GP freight container)

Figure B.2 – Side wall (for 20 ft test container): Panel sections



Key

A1 to A5	Side panel sections right-hand side
B1 to B5	Side panel sections left-hand side
D	Door
E	End wall

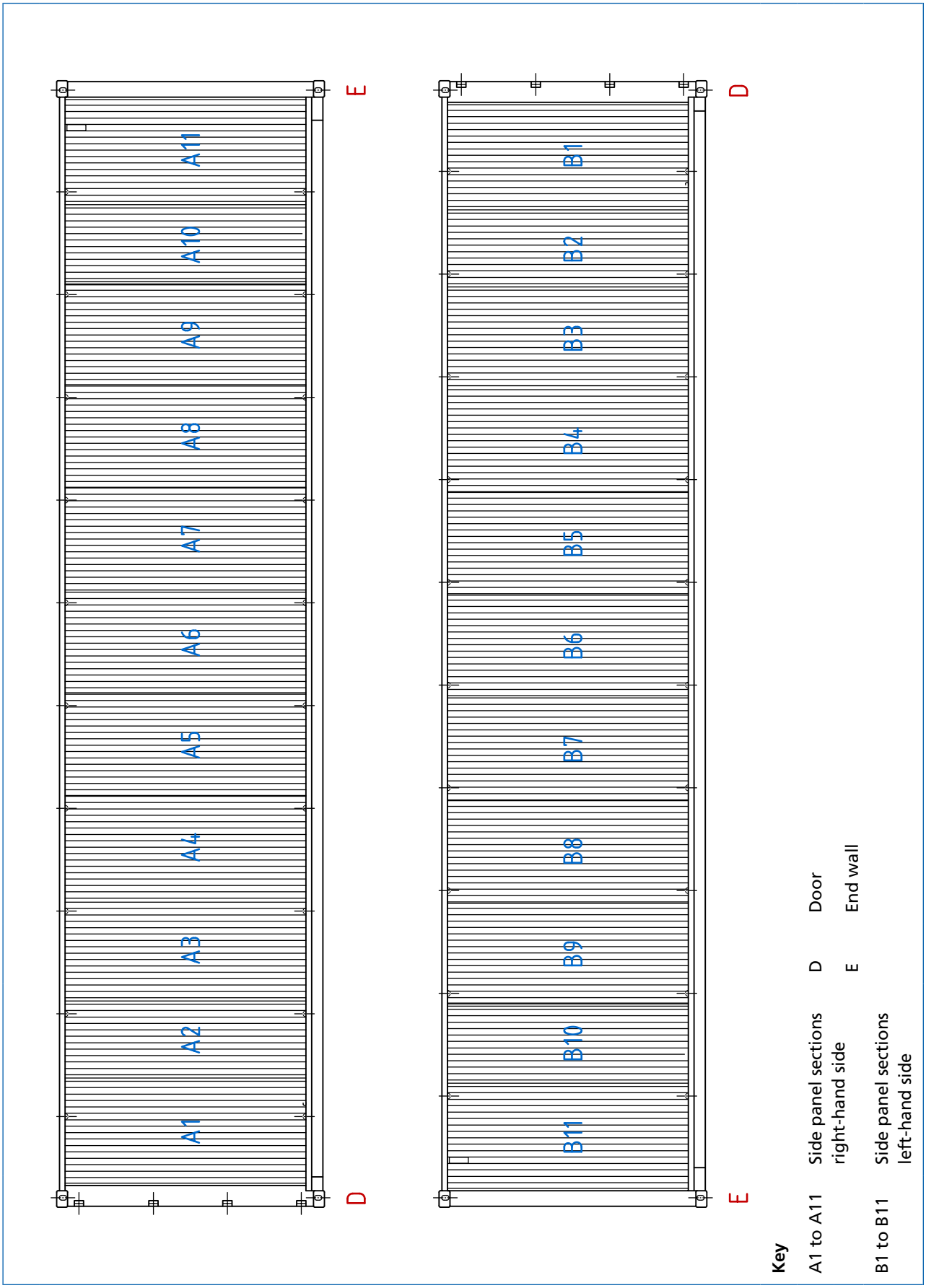
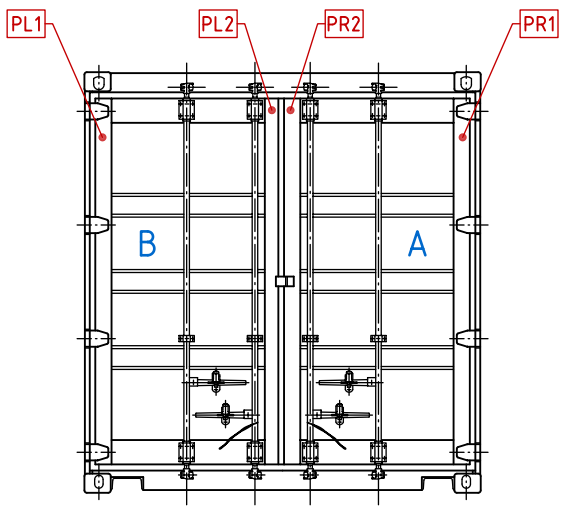


Figure B.3 – Side wall (for 40 ft test container): Panel sections

Figure B.4 – Door: Panel sections and door posts

Dimensions in mm



Key

□	Door post label
A	Right-hand panel
B	Left-hand panel

B.2.2 **Two accelerometers** with a minimum amplitude range of 200*g*, a maximum lower frequency limit of 1 Hz and a minimum upper frequency limit of 3 000 Hz.

NOTE *The preferred method is to attach each accelerometer to a flat mounting plate by means of bolting and to bond the mounting plates to the corner fittings.*

B.2.3 **Test platform**, comprising a structure capable of sustaining (without significant damage) an impact as defined in **B.4.8** with the test container mounted securely in place.

The test platform shall be equipped with means of ensuring a direct load transfer through the bottom corner fittings at the end of impact, e.g. solid stop blocks.

The test platform shall be equipped with four devices conforming to BS 3951-1.2, ISO 1161, for securing the test container.

The test platform shall be equipped with a cushioning device to provide a duration of impact that will create the impact defined in **B.4.8**.

The test platform shall be designed such that an impacting mass is free to rebound after impact.

B.2.4 **A means to monitor that the restraining system does not touch the interior of the test container doors**, before, during and after each impact.

B.2.5 **A means to monitor that a fitted valve does not touch the interior of the test container walls, doors or roof**, before, during and after each impact.

B.2.6 **A means of measuring the deformation of the test container**, at the measurement locations specified in Figure 1 for the end wall and Figure 2 for the side walls to a minimum accuracy of ±1 mm.

B.2.7 **Mass**, capable of creating the impact as defined in **B.4.8**.

B.2.8 **A means of measuring the velocity** of the moving test platform or the moving mass at the moment of impact.

B.2.9 **Analogue-to-digital data acquisition system**, capable of recording the shock disturbance as acceleration versus time history at a minimum sampling frequency of 500 samples per second. The analogue-to-digital data acquisition system shall incorporate a low-pass anti-aliasing analogue filter with a corner frequency set to a minimum of 200 Hz and a maximum of 20% of the sampling rate, and a minimum roll off rate of 40 dB/octave.

B.2.10 **A means of storing the acceleration versus time histories** in electronic format, so that they can be subsequently retrieved and analysed.

B.2.11 **Video photographic equipment** (optional)

B.3 Preparation of the test piece (flexitank system)

B.3.1 Take a minimum of 5 random panel thickness measurements for each panel section (see Figure B.1 to Figure B.4) and calculate the thickness as an average of the 5 measurements.

NOTE 1 *This average thickness is recorded in the test report (**C.3.1.3**) under the corresponding panel section heading.*

NOTE 2 *The thickness and section dimensions should be obtained by physically measuring the component thicknesses by use of a suitable ultrasonic thickness gauge.*

NOTE 3 The thickness gauge should be used in accordance with the manufacturer's instructions. Caution should be exercised in obtaining a true thickness reading and in avoiding areas where thickness readings might be erroneous, e.g. areas containing excessive paint, weld splatter, or gouges.

B.3.2 The flexitank system is tested without the use of constraining equipment.

B.3.3 The flexitank system is tested without the use of any materials or devices inserted between the restraining system and the door.

B.3.4 The flexitank is tested with the maximum number of fittings as commercially operated.

B.3.5 Weigh the empty flexitank system (excluding the container and the restraining system) and record the mass in kg.

B.3.6 Weigh the restraining system and record the mass in kg.

B.3.7 Fit the freight container lining, if used, flexitank and restraining system, if used to the test container (**B.2.1**) in accordance with the flexitank manufacturer's installation instructions. Fit the flexitank such that when the flexitank is loaded, it is not in contact with the doors or roof of the test container. Ensure that the fitted valve(s) and restraining system are not in contact with the walls, doors or roof of the test container.

B.3.8 Attach each accelerometer (**B.2.2**) to the test container at the outer end or side face of the two adjacent bottom corner fittings closest to the impact source. Align the accelerometers so that they can be used to measure the acceleration in the longitudinal axis of the test container.

B.3.9 Measure the deformation of the side walls and front wall.

B.4 Procedure

B.4.1 Record the test site temperature (°C) and humidity (%).

B.4.2 Fill the flexitank with water to its declared capacity, with a relative tolerance of ±100 L. The flexitank may be filled before or after mounting on the test platform (**B.2.3**).

B.4.3 Weigh the flexitank system (with the flexitank filled with water) and record the mass in kg.

***NOTE** Weighing the test container, is to check that the flexitank has been filled with the correct volume of water, i.e. its declared capacity, with a relative tolerance of ±100 L. This test is only suitable for flexitanks that carry a commodity up to a maximum mass of 24 000 kg and a maximum volume of 24 000 L.*

B.4.4 Orient the test container on the test platform in a way that the test container rear end (doors) facing the impacting mass and the longitudinal axes of the test container and the test platform are aligned.

B.4.5 Take a photograph of the set up with the left-hand door of the test container closed and the right-hand door fully open. The photograph shall be taken from an angle of 45° to the rear of the test container from the right-hand side.

B.4.6 Record the following data:

a) the size in mm (**B.2.6**) of deformations of the test container for the:
   1) end wall at the measurement locations specified in Figure 1;
   2) side walls at the measurement locations specified in Figure 2.

   ***NOTE** When measuring the test container deformations, a reference line should be set up for each of the side walls and end wall using the outer vertical faces of the corner castings. This is to ensure a consistent base line for measurement.*

b) whether there is any visually detectable leakage;

c) whether the flexitank and restraining system are or have been in contact with the interior of the test container doors (**B.2.4**);

d) whether any fitted valve is or has been in contact with the interior of the test container walls, doors or roof (**B.2.5**).

B.4.7 Secure the test container on the test platform using all four of its corner fittings so as to restrain its movement in vertical and transverse directions. Minimize any clearance between the corner fittings of the test container and the load transfer devices in longitudinal direction at the impacting end of the test platform allowing space for the impacting mass to freely rebound after impact.

B.4.8 Create a single impact between the test container and the mass (**B.2.7**) either by the test platform striking a stationary mass or the test platform being struck by a moving mass, such that the measured impact velocity (**B.2.8**) results in an acceleration amplitude of (2 ± 0.2)*g* (gravitational unit) at a low-pass filtering of 16 Hz (4-pole Butterworth) is registered in the accelerometer signals (**B.2.2**, **B.2.9**, **B.2.10**, **B.2.11**) from the bottom corner fittings.

NOTE *Video photographic documentation during the rail impact test can provide valuable evidence.*

B.4.9 Following the first 2*g* impact, record the data in accordance with **B.4.6**.

B.4.10 Orient the test container on the test platform in a way that the test container front wall is facing the impacting mass and the longitudinal axes of the test container and the test platform are aligned.

B.4.11 Secure the test container in accordance with **B.4.7**, create a single impact in accordance with **B.4.8** and following the second 2*g* impact, record the data in accordance with **B.4.6**.

B.4.12 Following the two 2*g* impacts, discharge the water from the flexitank and record the size in mm of the deformations of the test container for the following:

a) end wall at the measurement locations specified in Figure 1;

b) side walls at the measurement locations specified in Figure 2.

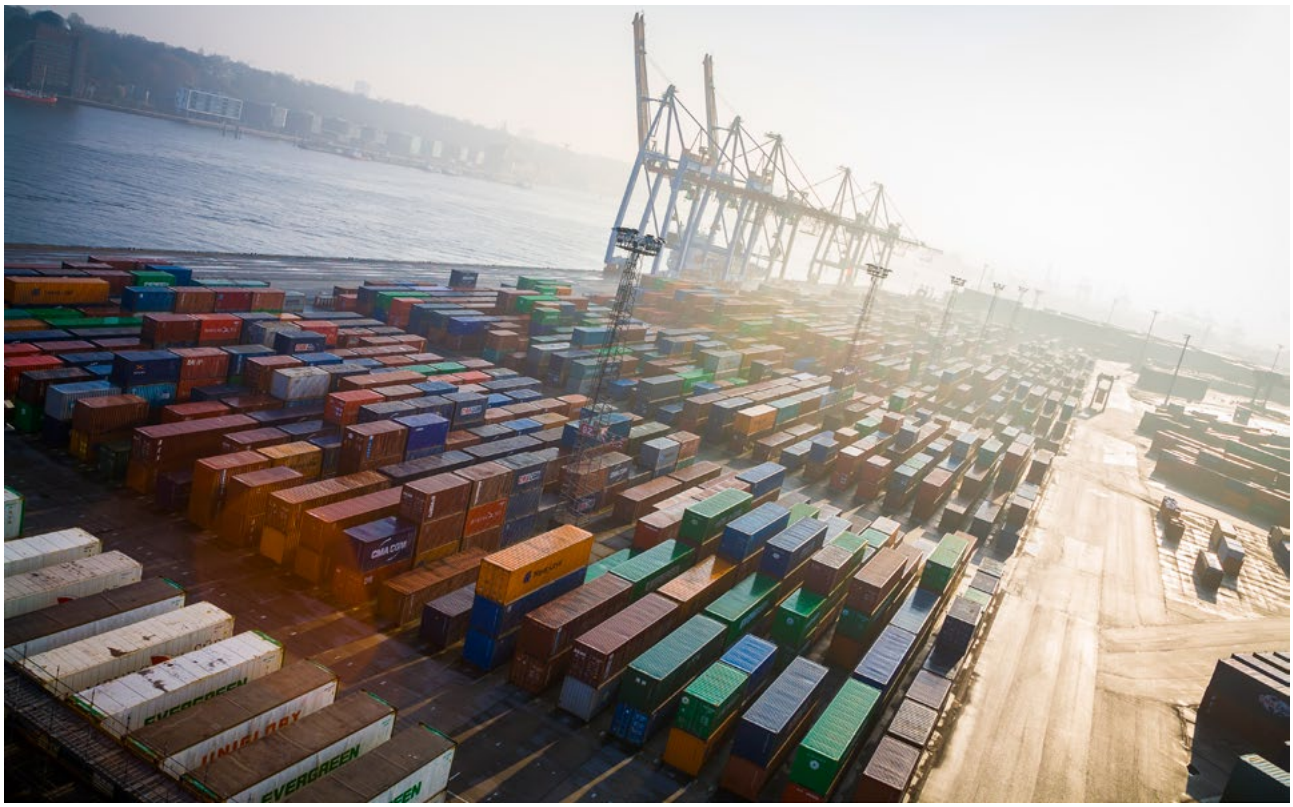
B.4.13 Remove the flexitank from the test container, and record whether there is any visually detectable leakage.

B.5 Test report

B.5.1 The test report shall be in accordance with Annex C.

B.5.2 The test report shall be reproduced on the test company's headed paper, with the test reference number and date included in the footer of each page, and each page of the test report company stamped.

NOTE *The test report may be in electronic format.*



Annex C (normative)
Flexitank system standard rail impact test report

C.1 General information

Name and address of flexitank manufacturer	
Name and address of company commissioning the test	
Manufacturing address	
Test reference number	
Flexitank type (e.g. single-layer, single-layer with woven sleeve, multilayer with woven sleeve)	
Test method	PAS 1008:2016, Annex B

C.2 Test location and conditions

Name and address of testing facility	
Date	
Temperature and humidity	
Manager in charge of testing	
Name, position and signature of test manager	

C.3 Equipment being tested

C.3.1 GP freight container

C.3.1.1 GP freight container information

GP freight container supplied by	
Unique GP freight container number	
Tare mass (kg)	

C.3.1.2 Container safety convention (CSC) plate information

Photograph of CSC plate (to capture information) [A]	
GP freight container manufacturer	
Date of manufacture	
Current examination (Yes/no)	
Maximum gross mass (kg)	
Allowable stackable weight (kg)	
Racking test load value (kg)	
End wall test load [B] (N)	
Side wall test load [B] (N)	
Allowable stackable weight (one-door off) [B] (kg)	
Racking test load value (one-door off) [B] (kg)	
End wall strength (one-door off) [B] (kg)	

[A] The CSC plate information shall be provided as either a photograph or in the form.
[B] Where provided on the CSC plate, the information shall be captured.

C.3.1.3 Test container panel thicknesses

NOTE *See* ***B.2.1*** *and* ***B.3.1****.*

Section	Panel section measurement (in mm)										
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
Side wall A – LH [A)]											
Material type [B)]											
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Side wall B – RH [A)]											
Material type [B)]											

	A	B
End wall		
Material type [B)]		

	A
Door panel A – RH	
Material type [B)]	

	B
Door panel B - LH	
Material type [B)]	

[A)] For 20 ft test container, panels 1 to 5; for a 40 ft container, panels 1 to 11.

[B)] For material type, the type of steel and grade of steel (e.g. ASTM A588) is recorded.

C.3.2 Flexitank system

C.3.2.1 Flexitank information

Flexitank serial number	
Flexitank model/name	

C.3.2.2 Flexitank specifications

Volume – nominal capacity (L)	
Volume – when tested (L)	
Number of layers (excluding sleeve)	
Sleeve (Yes/no)	
Tare mass (empty)	

	Material	Thickness (mm)	Mass/square metre ($kg \cdot m^{-2}$)
Layer 1 [A)]			
Layer 2			
Layer 3			
Layer 4			
Layer 5			
Layer 6			
Sleeve 1			
Sleeve 2 (if used)			

[A)] Layer 1 is the layer that is in contact with the commodity.

C.3.2.3 Valve configuration

Valve type	Manufacturer	Model number	Design	Size
Top				
Bottom				
Air vent/relief				
Other				

C.3.2.4 Restraining system

Technical drawing of restraining system	
Photograph of restraining system to be included here. Photograph to be taken with left-hand door closed and the right-hand door open, from an angle of 45° to the rear of the test container	
Restraining system type	
Including materials used	
Dimensions and thickness	
Mass of restraining system	

C.4 Test results

	Prior to filling	After filling (see **B.4.6** and Table 4)	After first 2*g* impact (see **B.4.9** and Table 4)	After second 2*g* impact (see **B.4.11** and Table 4)	After discharge (see **B.4.12** and Table 5)
Acceleration					
Minimum requirement for acceleration			(2 ± 0.2)*g* towards doors	(2 ± 0.2)*g* towards end wall	
Visually detectable leakage					
Requirement		None	None	None	None
Contact with doors					
Restraining system					
Requirement		No contact	No contact	No contact	No contact
Valve					
Requirement		No contact	No contact	No contact	No contact
End wall [A)]					
Maximum deflection permitted		40 mm	40 mm	40 mm	7 mm
Side wall A [A)]					
Maximum deflection permitted		40 mm	40 mm	40 mm	8 mm
Side wall B [A)]					
Maximum deflection permitted		40 mm	40 mm	40 mm	8 mm
Flexitank touching doors (Yes/no)					
Valve touching roof (Yes/no)					

The test results are within the maximum allowable deformation criteria (Yes/no)	
Detectable leakage during testing (Yes/no)	
Test passed overall (Pass/fail)	

NOTE *The test report should detail the acceleration curves.*

C.5 Further comments (optional)

Annex D (normative) Testing

NOTE Type tests are tests made before supplying a particular type of item on a general commercial basis, to determine whether the item has satisfactory performance characteristics to be suitable for the intended application. Sample tests are tests performed on samples taken from a completed item, at a specified frequency, to determine whether the finished product meets the specified requirements. Routine tests are tests performed on each manufactured item to check whether the item meets the specified requirements.

D.1 Materials

D.1.1 The flexitank film and sleeve shall be subject to type testing to determine whether its material properties meet the requirements specified in Clause **4**.

D.1.2 The flexitank film shall be subject to sample testing to determine whether the material properties determined in accordance with test standards specified in Clause **4** have been maintained. Sample testing shall be carried out at a minimum once per 100 flexitanks manufactured per material specification/ size irrespective of the flexitank design or capacity and where a new material roll from a new batch or a new batch of material is used.

D.2 Loading and discharging valves

D.2.1 The loading and discharging valve shall be subject to type testing to determine whether it conforms to Clause **5** for leakage before use in the manufacture of the flexitank.

D.2.2 Each loading and discharging valve shall be subject to routine testing to determine whether it conforms to Clause **5** for leakage. The routine testing shall be carried out in accordance with Annex D, a maximum of 72 hours before dispatch of the valve to the finished goods inventory.

D.3 Flexitank system rail impact test

D.3.1 The flexitank system shall be subject to type testing to determine whether it conforms to Clause **6** for performance.

D.3.2 The type test shall be repeated where changes are made to the design (e.g. change in flexitank film used) or manufacture (e.g. change of supplier of a flexitank film) of the flexitank beyond the following permitted variations:

a) a decrease in the flexitank capacity that does not involve a change in either the material used or a reduction in the flexitank film layer thickness or material properties;

b) a decrease in the number of flanges/openings;

c) an increase in any flexitank film layer thickness that does not involve a reduction in the determined material properties;

d) for a multilayer flexitank, the addition of an extra flexitank film layer as the outermost layer (not including the woven propylene sleeve) that has the same material properties as an existing flexitank film layer;

   NOTE The addition of layers is most likely to have an impact on the welding property.

e) for a single-layer flexitank, the addition of an outer structural sleeve (e.g. woven polypropylene);

f) for a single-layer flexitank, the addition of a non-structural layer as an outermost layer serving as a contaminant barrier.

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For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM A588, *Standard specification for high-strength low-alloy structural steel, up to 50 ksi [345 MPa] minimum yield point, with atmospheric corrosion resistance*

BS EN 12266-1:2012, *Industrial valves – Testing of metallic valves – Part 1: Pressure tests, test procedures and acceptance criteria – Mandatory requirements*

BS EN ISO 9000 (series), *Quality management systems*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

BS ISO/TR 15070, *Series 1 freight containers – Rationale for design and structural test criteria*

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