ประกาศกระทรวงอุตสาหกรรม

ฉบับที่ ๔๙๗๐ (พ.ศ. ๒๕๖๐)
ออกตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม
พ.ศ. ๒๕๑๑
เรื่อง กำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม
เทคโนโลยีทางเรือและทางทะเล - ยางกันเรือกระแทกแบบสูบลม -
เล่ม ๒ : ประเภททนความดันต่ำ

อาศัยอำนาจตามความในมาตรา ๑๕ แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. ๒๕๑๑ ซึ่งแก้ไขเพิ่มเติมโดยพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม (ฉบับที่ ๗) พ.ศ. ๒๕๕๘ รัฐมนตรีว่าการกระทรวงอุตสาหกรรมออกประกาศกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม เทคโนโลยีทางเรือและทางทะเล - ยางกันเรือกระแทกแบบสูบลม - เล่ม ๒ : ประเภททนความดันต่ำ มาตรฐานเลขที่ มอก. 2771 เล่ม 2 - 2559 ไว้ ดังมีรายละเอียดต่อท้ายประกาศนี้

ทั้งนี้ ให้มีผลตั้งแต่วันที่ประกาศในราชกิจจานุเบกษาเป็นต้นไป

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มาตรฐานผลิตภัณฑ์อุตสาหกรรม
เทคโนโลยีทางเรือและทางทะเล –
ยางกันเรือกระแทกแบบสูบลม –
เล่ม 2: ประเภททนความดันต่ำ

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ กำหนดขึ้นโดยรับ ISO 17357-2:2014 Ships and marine technology – Floating pneumatic rubber fenders – Part 2: Low pressure มาใช้โดยวิธีพิมพ์ซ้ำ (reprinting) ในระดับเหมือนกันทุกประการ (identical) โดยใช้ ISO ฉบับภาษาอังกฤษเป็นหลัก

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ กำหนดวัสดุ สมรรถนะและมิติของยางกันเรือกระแทกแบบสูบลมประเภททนความดันต่ำ ที่มีจุดประสงค์เพื่อให้เรือเข้าเทียบจอดเรือในที่จอดเรือหรือจอดเรือต่อกัน มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ยังกำหนดวิธีการทดสอบและวิธีการตรวจสอบยางกันเรือกระแทกแบบสูบลมประเภททนความดันต่ำด้วย

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ ไม่ได้ครอบคลุมอันตรายที่อาจเกิดขึ้นจากการใช้งาน ซึ่งเป็นหน้าที่ของผู้ใช้ต้องรับผิดชอบ ในการกำหนดข้อปฏิบัติด้านความปลอดภัยและสุขภาพอย่างเหมาะสม รวมทั้งพิจารณาข้อจำกัดกฎระเบียบก่อนการใช้มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้

รายละเอียดให้เป็นไปตาม ISO 17357-2:2014

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 4, *Outfitting and deck machinery*.

ISO 17357-1 together with ISO 17357-2 cancels and replaces ISO 17357:2002.

ISO 17357 consists of the following parts, under the general title *Ships and marine technology — Floating pneumatic rubber fenders*:

— *Part 1: High pressure*

— *Part 2: Low pressure*

Introduction

This International Standard has been developed to provide guidelines on the quality and performance of all floating pneumatic rubber fenders. Floating pneumatic rubber fenders can play an important role in a ships safe berthing operation and this International Standard is seen as a technical reference to ensure necessary product standards.

Essentially there are two main types of floating pneumatic rubber fender, defined as either high- or low-pressure fenders. Although manufactured using different techniques, both high and low-pressure fenders work by the same principle. The resistance to berthing vessel momentum is provided by a reaction pressure due to compression of the air inside the fender when deformed by the vessels hull. The kinetic energy of the berthing vessel is absorbed during the work done to compress the air inside the fender. Fenders are sized according to the expected duty of the fender in terms of the energy absorption (EA) requirements which will be at the most basic level, a function of the vessel mass and velocity.

Throughout this International Standard, the minimum essential criteria are identified by the use of the key word “shall”. Recommended criteria are identified by the use of the key word “should”, and while not mandatory are considered to be of primary importance in providing serviceable, economical and practical connectors. Deviation from the recommended criteria should occur only after careful consideration, extensive testing and thorough service evaluation have shown alternative methods to be satisfactory.

The documents in the Bibliography provide information on the usage of the fenders.

INTERNATIONAL STANDARD ISO 17357-2:2014(E)

Ships and marine technology — Floating pneumatic rubber fenders —

Part 2:
Low pressure

1 Scope

This part of ISO 17357 specifies the material, performance, and dimensions of low-pressure floating pneumatic rubber fenders, which are intended to be used for the berthing, and mooring of a ship to another ship or berthing structure. It also specifies the minimum test and inspection procedures for floating low-pressure pneumatic rubber fenders.

This part of ISO 17357 does not address the methods for selecting the correct fender type or any safety hazards associated with its use. It is the user's responsibility to establish appropriate safety and health practices and determine the applicability of regulatory limitations before using this part of ISO 17357.

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.

ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48, *Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 1421, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 2411, *Rubber- or plastics-coated fabrics — Determination of coating adhesion*

BS 3424–5, *Testing coated fabrics. Methods 7A, 7B and 7C. Methods for determination of tear strength*

FED-STD-191A 1978, *Textile test methods*

ASTM D751, *Standard test method for Coated Fabrics*

ISO 4674-1, *Rubber- or plastics-coated fabrics — Determination of tear resistance — Part 1: Constant rate of tear methods*

3 Terms and definitions

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

NOTE The following definitions are specifically applicable to low pressure floating pneumatic rubber fenders.

3.1
bead ring
ring of several layers of high-tensile steel wire which is an integral part of moulded ends, reinforcing the end around which the end closure plate assembly is clamped

3.2
clamped end fitting
metal assembly comprising of end link plates and mooring plates, fitted to the ends of the clamped end fenders to seal the ends of the fender and also to provide mooring points

3.3
clamped end type
low-pressure fenders up to and including 2,3 m diameter, manufactured from a number of longitudinal panels of coated textile and sealed by means of clamped end fittings

Note 1 to entry: Typically the longitudinal panels are tapered at the ends to form a parabolic shape, though for smaller fenders the ends can be folded to form a "parcel end" design.

3.4
coated textile
vulcanized-synthetic-rubber-covered high-tenacity continuous filament woven nylon textile

Note 1 to entry: The outer coating is designed to give a high level of resistance to abrasion and other external forces. The combination of the inner and outer synthetic rubber coating provides the required resistance of permeability to the escape of the compressed air essential for the demands of the product.

3.5
end closure plate assembly
metal assembly fitted to the low-pressure moulded end fenders to close off both ends of the fender and, in addition, at one end, the inflation air valve and pressure gauge valve are fitted

Note 1 to entry: The mooring fittings are attached to this assembly.

3.6
guaranteed energy absorption
energy the fender can absorb without permanent deformation or failure

3.7
initial internal pressure
air pressure at which an uncompressed fender operates, i.e. the initial pressure to which a fender is inflated

3.8
low-pressure floating pneumatic rubber fender
fender which is manufactured essentially from a textile reinforced rubber material with compressed air inside, at a typical initial pressure of 7 kPa, to enable it to float on the water and act as a shock absorber between ship and ship or between ship and berthing structures when they are coming alongside each other on the water

3.9
moulded end type
low-pressure fenders of 2,8 m diameter and above, which are manufactured with a cylindrical body fabricated from a number of longitudinal panels of coated textile, onto which are attached hemispherical-shaped moulded sections at each end

3.10
reaction force
force produced by a fender reacting to a compressive force

Note 1 to entry: Reaction force is equal to the force of the air pressure of the fender multiplied by the contact area of the fender to the ship or berthing structure.

4 Classification

4.1 Low-pressure fender types

Low-pressure fender types are defined as follows:

a) clamped end type;

b) moulded end type.

4.2 Initial internal pressure

Unless specified otherwise, the initial internal pressure for low-pressure pneumatic rubber fenders is 7 kPa.

5 Ordering information

5.1 Information to the manufacturer

The fender order, contract, or enquiry should state the following information:

a) the International Standard number and applicable year, i.e. ISO 17357-2;

b) fender type (see 4.1);

c) initial internal pressure (see 4.2);

d) fender size: nominal fender diameter and length (see Tables 1, 2, or 3);

NOTE If the purchaser requests other sizes, they shall satisfy the requirements of 6.3.

e) fender colour (if not specified, the colour shall be black);

f) if inspection/evaluation by a major classification is required, see Clause 12.

5.2 Information from the manufacturer

In order to confirm that the products meet the requirements of this part of ISO 17357, the purchaser can request the manufacturer to provide the following information prior to order placement.

a) Prototype fender test certificate

This certificate confirms successful results of the tests in Clause 8, which are evaluated by a major classification society and are conducted no more than 10 years prior to inquiry date.

b) Commercial fender inspection and test certificate

This certificate confirms successful results of the inspections and the tests in Clause 9, which shall be performed on fenders which have a diameter equal to or larger than the inquired fender with the same or higher internal pressure, and are evaluated by a major classification society and are conducted no more than 10 years prior to inquiry date.

6 Low-pressure fender requirements

6.1 Clamped end fender requirements

6.1.1 Floating low-pressure pneumatic rubber fenders with clamped ends shall consist of a cylindrical body mainly parallel over its central section, either tapering into integral paraboloid shaped ends, or

folded into a “parcel end” design. The whole construction forms an airbag, which shall be filled with compressed air.

6.1.2 The fender body shall be manufactured from a number of longitudinal panels of a vulcanized-synthetic-rubber-coated textile.

6.1.3 The inner and outer rubber coatings shall satisfy the values in Table 2.

6.1.4 The coated textile panel material shall satisfy the values in Table 3.

6.1.5 The panels of coated textile shall be bonded together so that the seam strength is sufficient to contain the air pressure developed during compression of the fender.

6.1.6 The fender is sealed at the extreme ends by means of the clamped end fittings comprising a number of interlocking metal links and mooring plates bolted together through the material.

6.1.7 For 1,8 m to 2,3 m diameter clamped end fenders, the inflation fitting assembly shall be fitted onto the sloping section of one end of the fender in such a position that it will not inhibit the fender from compressing to 60 %. The inflation fitting assembly shall be comprised of a recessed clamping flange into which two individual valves for air inflation and for gauging the air pressure shall be fitted.

6.1.8 For clamped end fenders less than 1,8 m diameter, the inflation fitting with separate inflation and pressure test valves is not required and shall be replaced by a single dual-purpose inflation and pressure gauge valve fitted direct to the coated textile.

6.2 Moulded end fender requirements

6.2.1 Floating low-pressure pneumatic rubber fenders with moulded ends shall consist of a cylindrical body largely parallel over its central section onto which hemispherical moulded ends are attached. For very large diameter moulded end fenders, the cylindrical section can have tapered ends onto which the hemispherical shaped end mouldings are attached. The whole construction forms an air bag, which shall be filled with compressed air.

6.2.2 The cylindrical body shall be manufactured from a number of longitudinal panels of a vulcanized-synthetic-rubber-coated textile.

6.2.3 The inner and outer rubber coatings shall satisfy the values in Table 2.

6.2.4 The coated textile panel material shall satisfy the values in Table 3.

6.2.5 The panels of coated textile shall be bonded together so that the seam strength is sufficient to contain the air pressure developed during compression of the fender.

6.2.6 The hemispherical moulded ends shall consist of a reinforcement of high-tenacity weftless nylon cord sandwiched between inner and outer layers of rubber, all vulcanized firmly together. The rubber strapping shall satisfy the values specified in Table 2. The reinforcement cord layers shall be strong enough to hold the internal pressure in both the compressed and non-compressed situations.

6.2.7 The reinforcement shall wrap around the integral bead ring where appropriate.

6.2.8 The moulded end shall be attached to the body of the fender by means of a circumferential seam so that the seam strength is sufficient to contain the air pressure developed during compression of the fender.

6.2.9 There shall be a flange opening at both ends into which the end closure assembly is clamped to close off the end of the fender and to provide attachment for the mooring fittings. At one end, the end closure assembly shall incorporate two individual valves: one for air inflation and one to gauging air pressure.

6.3 Size requirements

Sizes not listed in Table 1 shall satisfy all the requirements in this subclause, using the pressure requirements of the next-larger-diameter size.

EXAMPLE A 2,5-m-diameter low-pressure fender shall satisfy the pressure requirements of a 2,75 m diameter low-pressure fender.

7 Performance

7.1 Specification of performance

The performance of low-pressure floating pneumatic rubber fenders shall be specified in terms of guaranteed energy absorption (GEA), reaction force at GEA deflection, and hull pressure at GEA deflection.

7.2 Performance curves

The relationship between the deflection percentage, reaction force, inner pressure (which is equal to the hull pressure), and energy absorption is shown in Figure 1. The reaction force, the inner pressure, and the energy absorption of the fender increase as the deflection percentage increases. From the GEA value, point A is determined on the energy absorption curve and the corresponding deflection percentage is read as GEA deflection. The reaction force and the hull pressure are then obtained at that deflection percentage value.

7.3 Fender performance

7.3.1 The moulded and clamped end low-pressure fenders shall satisfy the values specified in Table 1.

7.3.2 GEA values shown in Tables 1, 2, and 3 shall be obtained at (60 ± 5) % deflection.

7.3.3 The tolerance of the reaction force at GEA deflection shall be ±10 %

7.3.4 Fender performance can be calculated by the formula, which shall be established based on the performance test described in 8.1.

8 Performance confirmation of prototype fender test

8.1 General

Each fender, involving different methods of basic construction and/or design, shall require a prototype test.

Fenders of lesser diameter than a prototype confirmed fender, incorporating the same basic design, construction, and fabrication methods, but satisfying all requirements of this part of ISO 17357, do not require a prototype test.

The manufacturer shall provide the certificate confirming the successful results of the tests, which are evaluated by a major classification society, and the performance confirmation of prototype fender test shall be done every 10 years.

8.2 Performance test, parallel compression test

8.2.1 To determine the performance of the fenders given in Clause 7, a performance test shall be performed. Applying a compressive force perpendicularly to the fender, the fender shall be compressed until its energy absorption reaches the GEA value. Compression speed shall not exceed 80 mm/min. The reaction force and internal pressure shall be recorded at least every 5 % deflection. The percentage deflection, y, and the energy absorption, a, are calculated as follows.

$$y = \frac{L_c}{D} \times 100 \quad (1)$$

where

y is the percentage deflection;

L_c is the compression length, in millimetres;

D is the original diameter (i.e. the fender diameter at initial pressure), in millimetres.

$$a = \int R(x)\,dx \quad (2)$$

where

$R(x)$ is the reaction at a given deflection;

dx is the incremental deflection.

The test shall be repeated twice with an interval of 5 min between the two tests. The energy absorption and the reaction force shall be obtained from the mean value of the two test records.

A fender meets the required GEA performance if it achieves 100 % of its GEA energy absorption without exceeding 65 % deflection and 110 % of its GEA reaction.

8.2.2 The test shall be performed using an actual-size fender or a miniature-size fender larger than 1/5 (one-fifth) the size of the actual diameter.

EXAMPLE In the case of 4,5 m diameter fenders, the performance shall be confirmed from the test result of a 4,5 m diameter fender or a fender larger than 0,9 m in diameter.

8.3 Angular compression test

8.3.1 An angular compression test shall be performed to determine the fender deformation property.

8.3.2 If the fender is too large to be mounted on the testing machine, the test can be performed on a miniature-size fender. The reduction scale shall be such that it will be ensured that the tests will be representative.

NOTE It has been shown that one-fifth or larger scale sizes are acceptable if relative performances at parallel and several angular conditions are to be compared at the same fender.

8.4 Durability test

8.4.1 A durability test shall be performed to verify that the products are suitable for use as fenders, and that they have sufficient durability to withstand the berthing energy.

8.4.2 The test shall comprise of at least 3 000 repetitive cycles of parallel compression from the original diameter to the maximum deflection. After 3 000 repetitive cycles, there shall be no cracks and other harmful defects on any part of the fender. No reduction of the GEA shall be accepted.

8.4.3 If the fender is too large to be mounted on the testing machine, the test can be performed on a miniature-size fender of greater than 1/30 scale size.

8.5 Compression recovery test

8.5.1 Fenders are compressed and released repeatedly over a very short period of time. Therefore, a compression recovery test shall be performed to confirm that the fenders have sufficient compression recoverability.

8.5.2 After compression of the fender to the guaranteed energy absorption deflection, the fender shall be kept in this compressed state for 1 min, then the load released instantaneously. The fender diameter shall recover more than 97 % of its original diameter within 5 min after the load to the fender is released.

8.5.3 The test shall be performed using an actual-size fender or a miniature-size fender larger than 1/5 (one-fifth) the size of the actual diameter

EXAMPLE In the case of 4,5 m diameter fenders, the performance shall be confirmed from the test result of a 4,5 m diameter fender or a fender larger than 0,9 m diameter.

8.6 Puncture resistance test

8.6.1 A puncture resistance test shall be performed to confirm that the products have sufficient puncture resistance strength.

8.6.2 The test shall be conducted in accordance with ASTM D751 [screwdriver tip, of width (7,92 ± 2,5) mm, thickness (0,8 ± 0,1) mm, tip edges rounded to radius 0,25 mm, ring clamp internal diameter 76,2 mm rather than 44 mm].

8.6.3 The specimen shall be the same coated textile used to fabricate the main fender body.

8.6.4 The force required to break through the specimen shall be at least 890 N.

8.7 Recording condition

Ambient temperature and compression velocity shall be recorded for all of the performance confirmation tests.

9 Test and inspection for commercial fenders

9.1 General

Acceptance testing and inspection for purchased fenders shall be based on the tests and inspections indicated in this Clause.

9.2 Test of the fender body material

Testing of the outer and inner rubber coating compounds shall be conducted in accordance with the specifications shown in Table 2 and the results shall satisfy the requirements given in Table 2. Test item 1 shall be conducted on every batch of compound produced; item 2 shall be for type approval of any new rubber formulation.

The material test of the coated textile from which the fender body is manufactured shall be conducted in accordance with the specifications given in Table 3 and the results shall satisfy the requirements given in Table 3. Test items 1 to 4 shall be conducted on every production lot of coated textile.

9.3 Dimensional inspection

The dimensions of all fenders shall be inspected at the initial internal pressure and the results shall be within the tolerances below:

a) length: +10 %, –5 % ;

b) diameter: +10 %, –5 %.

The diameter shall be obtained based on the average of at least two different measurements taken at the middle of the cylindrical section of the fender.

9.4 Air leakage test

The air leakage test shall be conducted on all fenders at the initial pressure for 60 min, ideally in an area not subject to temperature variation. The test results shall confirm that any pressure drop shall not exceed 10 mbar.

NOTE If necessary, any adjustment for temperature variation can be made using the following formula.

$$P2 = P1\left(\frac{T2}{T1}\right)$$

where

$P1, P2$ are the absolute pressures;

$T1, T2$ are the absolute temperatures.

9.5 Hydrostatic pressure test

The hydrostatic pressure test shall be performed for 10 min at a hydrostatic pressure and there shall be no leakage of water and no defects during this test. The hydrostatic test pressure shall be conducted at four times the working pressure.

The frequency of the test shall be one per 20 fenders of each size. If the customer so requests, one per order of each size of fender if the quantity is less than 20.

Circumferential and longitudinal lengths shall be measured at 10 kPa pressure and the test pressure. The temporary elongation shall be as follows:

a) maximum circumferential temporary elongation: 15 %;

b) maximum longitudinal temporary elongation: 10 %.

$$e = \frac{L_t}{L} \times 100 \quad (3)$$

where

e is the temporary elongation, expressed as a percentage;

L_t is the length increased, in millimetres, at test pressure;

L is the length, in millimetres, at 10 kPa.

The increase in diameter and length shall be obtained by measuring the distance of two points marked circumferentially and longitudinally, at 10 kPa, on the middle of the fender body.

The distance between the two points shall be larger than one-fifth of the fenders diameter.

10 Marking

Each fender shall have markings on the body to indicate the following information:

— International Standard number for low-pressure floating pneumatic rubber fenders, and applicable year, i.e. ISO 17357-2:2014;

— initial internal pressure;

— size (diameter and length);

— date of manufacture or its abbreviation;

— full or abbreviation name of manufacturer;

— individual serial number;

— markings of the manufacturer: internal pressure rating shall be in suitable size and finish to enable clear identification.

11 Documentation

The manufacturer shall provide the purchaser with a certificate of conformity to demonstrate that the fenders have been tested and inspected as specified in this part of ISO 17357 and all the requirements have been met, together with a test and inspection report.

The manufacturer shall provide a maintenance manual, in the format of a logbook, where details could be recorded of all maintenance and repairs carried out on the fender. All maintenance and repairs should be carried out in accordance with the manufacturer's guidelines. The manufacturer shall also provide a handling/storage/packing recommendation.

The manufacturer should provide specific technical information relating to serial number, age, initial pressure, safety valves specification where appropriate, etc. to the purchaser/operational user upon request; such a request should be accompanied, where appropriate and possible, by a written permission from the original fender purchaser.

12 Inspection and evaluation by a qualified independent inspection service

The purchaser can, at his option, request the inspection and evaluation to be carried out by a major classification society for the ordered fenders. The inspection and evaluation shall cover the following points, depending on the fender type:

a) material certificate for the reinforcement used in the moulded ends, for low pressure moulded end fenders;

b) evaluation of test results for the coated material used in low-pressure fenders;

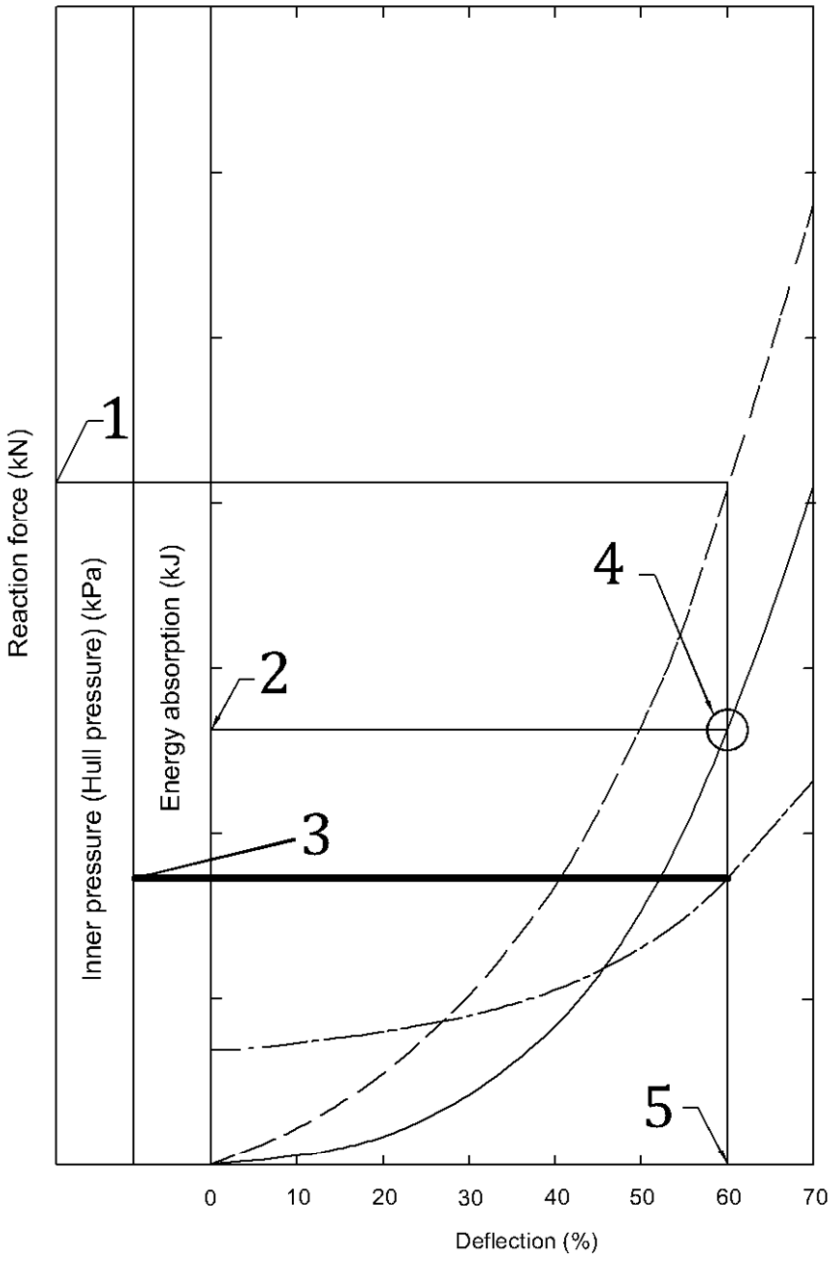
c) evaluation of test results of the rubber compounds;

d) evaluation of results of dimensional inspection;

e) evaluation of results of the air leakage test;

f) witness and confirmation of the hydrostatic pressure test;

g) witness and confirmation of marking.



Key

1	reaction force at GEA deflection
2	guaranteed energy absorption (GEA)
3	hull pressure at GEA deflection
4	point A
5	GEA deflection
———	energy absorption
— — —	reaction force
——·——	inner pressure

Figure 1 — Standard performance curve

Table 1 — Low-pressure fender size and performance requirements

Nominal size		Guaranteed energy absorption (GEA)	Reaction force at GEA deflection (R)	Hull pressure at GEA deflection (P)
Diameter m	Length m	Min value at deflection 60 % ± 5 % kJ	Tolerance ±10 % kN	Reference Value kPa
1,0	3,0	26	190	80
1,0	5,0	52	380	89
1,0	6,0	65	477	91
1,0	8,0	91	661	94
1,5	4,0	90	361	78
1,5	5,0	126	501	85
1,5	6,0	162	641	90
1,5	8,0	235	932	97
1,8	6,0	169	721	79
1,8	8,0	261	1 082	87
1,8	10,0	350	1 452	91
1,8	12,0	440	1 803	94
2,3	8,0	381	1 227	81
2,3	10,0	511	1 673	85
2,3	12,0	651	2 123	88
2,3	16,0	922	3 005	91
2,75	10,0	676	1 886	80
2,75	14,0	1 051	2 985	86
2,75	18,0	1 422	4 007	88
2,75	22,0	1 803	5 108	91
3,2	12,0	1 112	2 684	81
3,2	16,0	1 623	3 906	86
3,2	20,0	2 123	5 108	88
3,2	24,0	2 624	6 330	90
4,5	16,0	3 055	4 960	84
4,5	18,0	3 607	5 810	86
4,5	20,0	4 055	6 639	87
4,5	22,0	4 667	7 562	89
4,5	30,0	6 813	1 102 0	93

Table 2 — Low-pressure fender rubber coating compound requirements

Test	Specification	Test method
1) Unaged		
a) Hardness	60 – 70 IRHD	ISO 48
b) Tensile strength	>14 MPa	ISO 37
c) Elongation at break	>300 %	ISO 37
d) Compression set (24 h, 40 °C)	<40 %	ISO 815-1
2) Static ozone ageing		
168 h, 20 % extension, 50 pphma, 30 °C.	No visible cracks	ISO 1431-1

Table 3 — Low-pressure fenders coated textile requirements

Test item	Test method	Required value
1) Abrasion resistance	FED-STD-191 Method 5306 H22 wheels, 1 000 g load	25 000 cycles min to exposure of threads, outside fabric only
2) Breaking strength (kN/50mm)	ISO 1421	
Warp		8,75 min
Weft		11,00 min
3) Tear strength (N)	ISO 4674-1, Method B (single tear)	
Warp		1 110 min
Weft		1 110 min
4) Surface coat adhesion (N/50mm)	ISO 2411	
Outer cover		100 min
Inner lining		100 min

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