PD ISO/TS 14909:2012

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Fibre ropes for offshore stationkeeping — High modulus polyethylene (HMPE)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee TCI/77, Ropes and cordage and fishing nets.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2012

ISBN 978 0 580 69159 1

ICS 59.080.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2012.

Amendments issued since publication

Date	Text affected

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TECHNICAL SPECIFICATION

ISO/TS 14909

First edition
2012-05-01

Fibre ropes for offshore stationkeeping — High modulus polyethylene (HMPE)

Cordages en fibres pour le maintien en position des structures marines — Polyéthylène à haut module

Reference number
ISO/TS 14909:2012(E)

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Published in Switzerland

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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.

ISO/TS 14909 was prepared by Technical Committee ISO/TC 38, *Textiles*.

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Fibre ropes for offshore stationkeeping — High modulus polyethylene (HMPE)

1 Scope

This Technical Specification specifies the main characteristics and test methods of new high modulus polyethylene (HMPE) fibre ropes used for offshore stationkeeping.

2 Normative references

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

ISO 1968, *Fibre ropes and cordage — Vocabulary*

ISO 2060, *Textiles — Yarn from packages — Determination of linear density (mass per unit length) by the skein method*

ISO 2062, *Textiles — Yarns from packages — Determination of single-end breaking force and elongation at break using constant rate of extension (CRE) tester*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 18692:2007, *Fibre ropes for offshore stationkeeping — Polyester*

ASTM D885, *Standard Test Methods for Tire Cords, Tire Cord Fabrics, and Industrial Filament Yarns Made from Manufactured Organic-Base Fibers*

ASTM D1907, *Standard Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method*

ASTM D2256, *Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1968 and in ISO 18692 apply.

NOTE Marine grade fibre and marine finish are not used in HMPE ropes.

4 Materials

4.1 Rope core material

The fibre used in the core of the rope shall be high-tenacity HMPE, with an average tenacity of not less than 2,5 N/tex and in accordance with Annex A. Qualification and testing are given in Annex A.

4.2 Rope cover material

Where polyester yarn is used in the protective cover, its minimum tenacity shall be 0,73 N/tex.

4.3 Other materials

Other materials employed in rope assembly shall be identified in the rope design/manufacturing specification.

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For each material, the following shall be specified, as applicable:

a) base material;

b) size (linear density, mass per unit area, etc.);

c) relevant mechanical properties (tenacity, stiffness, etc.).

5 Requirements — Rope properties

5.1 Minimum breaking strength

The minimum breaking strength (MBS), of the rope (spliced), where tested according to Annex B, shall conform to Table 1.

Table 1 — Minimum breaking strength

Reference number[a]	Minimum breaking strength kN
63	2 500
71	3 200
80	4 000
90	5 000
100	6 300
106	7 100
112	8 000
118	9 000
125	10 000
132	11 200
140	12 500
150	14 000
160	16 000
170	18 000
180	20 000

[a] The reference number corresponds to the approximate outer diameter of the rope, in millimetres (mm). Actual diameters may vary for a given reference number.

5.2 Minimum core tenacity

The minimum tenacity of the rope core shall be 1,3 N/tex, measured in accordance with Annex B. All samples tested shall comply with the minimum value specified in this Technical Specification.

5.3 Creep properties

The rope shall have demonstrated creep properties in accordance with the test method in Annex C.

5.4 Particle ingress protection

If specified, the rope shall be constructed with a protection of the core against the ingress of particles having a size greater than 20 µm (microns) or as agreed between involved parties. Testing of the protection shall be performed in accordance with Annex B.

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6 Requirements — Rope layout and construction

6.1 General

The typical section of a rope shall comprise a rope core, providing intended strength and stiffness, and a cover.

6.2 Type of construction

The rope shall be of one of the following types of construction:

— torque-neutral construction (type TF);

— torque-matched construction (type TM).

The type of rope shall be specified by the purchaser.

NOTE Torque-neutral ropes are intended for use in mooring systems together with chain or torque-neutral spiral strand wire ropes. Torque-matched ropes are intended for use in mooring systems together with six-strand wire ropes or other non-torque-neutral wire ropes. Typical constructions are illustrated in Figures F.3 and F.4.

6.3 Rope core

6.3.1 The total number of yarns in the rope shall be at least the number specified in the rope design specification.

6.3.2 Splices are not allowed in the rope core or in sub-ropes, except for those at the end terminations.

Strands shall be uninterrupted over the length of the rope, with no splice or strand interchange.

NOTE Yarns can be joined, if necessary.

6.4 Protective cover

6.4.1 A protective cover shall be provided around the rope core to protect the rope core from mechanical damages during handling and in service.

The protection shall be water-permeable.

6.4.2 A polyester braided protective cover shall have a minimum thickness, t, with:

— $t = 7{,}0$ mm, for a reference number RN above 100;

— $t = 0{,}07 \times \text{RN}$, but not less than 4 mm, for a reference number RN less than 100.

Strand interchanges, i.e. the overlapping continuation of an interrupted strand with another identical strand following the same path, are permitted if they are properly staggered.

6.4.3 If HMPE or an alternative protective cover is used, it shall demonstrate a level of protection equal to that of a polyester braided cover.

6.4.4 A braided cover shall include coloured strands forming a pattern so that rope twist during installation or in service can be identified. There shall be a minimum of one ‘S’ coloured strand and one ‘Z’ coloured strand to form a cross on the rope.

An alternative protective cover shall be fitted with an axial stripe of contrasting colour, or other means to identify rope twist during installation or in service.

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6.5 Terminations

The terminations shall be made of an eye splice plus abrasion protection materials.

NOTE There can be other terminations, provided they do not jeopardize the rope performance.

The dimensions and arrangement of the eye shall match the diameter and groove shape of the thimble (or other interface piece) to be used for end connections, and shall be the same as for the rope prototype testing.

In the splice area, the integrity and the continuity of rope cover and particle-ingress protection, if fitted, shall be preserved or restored.

The eye and the splice area shall be further covered by an abrasion protection coating, such as polyurethane. Each termination shall be made according to the manufacturing practice as described in the termination specification.

6.6 Length of rope

The bedded-in lengths of the rope sections shall be calculated in accordance with 7.2.2, under 20 % of MBS, unless otherwise agreed on the purchase order or contract.

The calculated length of supplied rope shall be within ±1 % of the specified length.

For each supplied rope, the actual length at the reeling tension or during manufacture shall be reported as an indicative value.

Adequate extra length shall be manufactured in order to prepare the samples for testing, which are considered to be part of the delivery.

7 Rope testing

7.1 Type testing

7.1.1 General

Prototype tests shall demonstrate that ropes declared by the manufacturer as complying with the requirements laid down in this Technical Specification possess the properties specified in this Technical Specification. The purpose of these tests is to verify the design, material and method of manufacture of each size of finished rope, including protective cover and terminations.

All ropes to be prototype-tested shall comply with all the other requirements laid down in this Technical Specification. The tests specified below shall be carried out on a prototype rope for each size of rope, unless otherwise noted in this clause (Clause 7).

Any change in the design, material, method of manufacture, including protective cover and terminations, which can lead to a modification of the properties as defined in Clause 5 shall require that the prototype tests specified in this Technical Specification be carried out on the modified rope.

7.1.2 Sampling

The number of rope samples to be tested is given in Table 2.

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Table 2 — Number of samples for testing

Test	Number of samples
Breaking strength, core tenacity and stiffness	3
Creep	1[a]
Torque properties	1[b]
Linear density	1
Cyclic loading endurance	1[c]

[a] See 7.1.4.
[b] See 7.1.5.
[c] See 7.1.7.

7.1.3 Breaking strength, core tenacity and stiffness tests

7.1.3.1 Three samples shall be tested according to the procedure specified in Annex B, and each shall be capable of meeting the requirements of 5.1 (minimum breaking strength) and of 5.2 (minimum core tenacity).

7.1.3.2 The rope core tenacity and stiffness at end of bedding-in shall be calculated according to the methods defined in Annex B.

7.1.3.3 Measurement of the stiffness at other load levels shall be performed within the same tests.

These measurements are, however, not required where results are available for another qualified rope of the same design, material and method of manufacture, with a reference number of not less than 71 and where the stiffness at end of bedding-in does not differ by more than 10 %.

NOTE 1 These measurements are performed for design purposes only. There are no acceptance criteria on these parameters.

NOTE 2 These measurements can also be performed on a separate rope sample (see Annex B).

7.1.4 Creep properties test

One sample shall be tested for creep properties.

This test needs not be performed where data are available from the previous qualification test of another rope (or a sub-rope of it) with the same design, material and method of manufacture of rope core, and a size not less than reference number 71.

7.1.5 Torque properties tests

Where applicable, torque properties tests shall be performed according to the procedure specified in B.6 of ISO 18692:2007. These tests are, however, not required where results are available for another qualified rope of the same design, material, method of manufacture and termination, with a reference number of not less than 71.

7.1.6 Linear density test

The linear density shall be calculated from the measured mass and elongation according to the method defined in Annex B.

7.1.7 Cyclic loading (endurance) test

7.1.7.1 One sample shall be tested for cyclic loading. However, cyclic loading (endurance) tests performed with one size of qualified rope having the same design, material and method of manufacture including protective cover and terminations, is enough to qualify all sizes with an MBS between 50 % and 200 % of the size tested. The test for cyclic loading (endurance) is not required if such data are available.

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7.1.7.2 The cyclic loading (endurance) test shall be performed according to the procedure specified in B.5. A load range shall be selected by the manufacturer, and the rope shall withstand, without breaking, at least the number of cycles for that load range, as given in Figure B.2.

NOTE The value of the breaking force shows the rope residual strength and it is only for information.

7.1.8 Protective cover thickness

The thickness of the protective cover shall be verified.

The thickness of a braided cover shall be measured as twice the thickness of cover strands under the maximum braiding tension.

7.1.9 Particle ingress protection

See 5.4 and Annex B.

7.2 Testing of current production

7.2.1 Sampling and testing

Where the ropes are already declared by the manufacturer as complying with the requirements laid down in this Technical Specification, the rope tests, including breaking strength and core tenacity, as well as protective cover thickness verification, shall be performed on one sample taken from the manufacturing process for each type and size of rope.

7.2.2 Length measurement

The bedded-in length of each supplied rope section (other than short sections) shall be calculated from the linear density, ρ_l, using Formula (1):

$$L = \frac{(m_T - m_S) \cdot 1\,000}{\rho_{l,20}} \tag{1}$$

where

L is the length of the rope, expressed in metres (m);

m_T is the mass of the total rope length, expressed in kilograms (kg);

m_S is the mass of the materials used to form the eyes and the splices, expressed in kilograms (kg);

$\rho_{l,20}$ is the linear density of the rope, expressed in kilotex, obtained from the prototype test, in accordance with 7.1.6.

The length of short rope sections (i.e. sections of less than 20 m) shall be measured at a load of 2 % of MBS as the length between the centres of termination fittings (i.e. same as L_u on Figure B.1).

8 Report

8.1 Prototype rope

A complete and detailed report of the prototype rope manufacturing shall be supplied, including the fibre manufacturer, the fibre type and finish and all rope characteristics that can influence the mechanical properties, such as design, material specifications, method of manufacture, including protective cover and terminations, with sketches or pictures.

A complete and detailed report of type tests, with sketches or pictures of the test set-up, shall also be provided.

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8.2 Current production

The manufacturing report of supplied ropes shall be provided. A complete and detailed report of rope tests, with sketches and pictures of the test set-up, shall also be provided.

9 Certification

The certificate of approval and control, issued by a Recognized Classification Society (RCS), shall be presented together with the ropes, in order to ensure that testing and fabrication are in accordance with the approved specifications.

The rope manufacturer shall issue a rope declaration or obtain a rope certificate, including at least the following information:

a) reference number;

b) type of construction;

c) linear density;

d) MBS;

e) individual identification number;

f) length at a specified load;

g) length at the reeling handling tension.

NOTE A suggestion for a certificate of conformity can be found in Annex E.

10 Marking, labelling and packaging

10.1 Marking

A tape of at least 3 mm wide printed with a reference identifying the manufacturer shall be incorporated into the rope. The maximum distance between two consecutive markings shall be 0,5 m.

10.2 Labelling

An identification plaque or alternative means shall be installed close to the splice with the following information, as a minimum:

a) purchase identification;

b) individual identification number;

c) reference to this Technical Specification, i.e. ISO/TS 14909;

d) type of construction (TF or TM), in accordance with 6.2;

e) rope MBS;

f) rope length at a specified load, according to 7.2.2.

10.3 Packaging

If the assembly is packed on a spool or a reel, these shall be suitable for the applicable transportation means and of appropriate construction in terms of strength.

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The packaging shall be marked with the manufacturer's trademark and with the lot identification number.

NOTE The ropes can be delivered in steel reels or in containers. Alternative packaging designs can be provided with the prior approval of the purchaser.

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Annex A
(normative)

Fibre qualification and testing

A.1 General

This annex specifies the requirements for fibre qualification and testing.

A.2 Fibre specification

A.2.1 General information

A fibre specification shall include at least the information defined below:

a) identification and general properties of fibre;

b) detailed specification of physical and mechanical properties.

NOTE General properties of material can be found in the material safety data sheet.

A.2.2 Identification and general properties

The following information shall be provided in the fibre specification:

a) producer of fibres;

b) fibre designation;

c) fibre material (HMPE);

d) number of filaments;

e) nominal size (linear density);

f) average tenacity.

A.2.3 Physical and mechanical properties

The following information shall be provided in the fibre specification, including tolerances on specified properties:

a) linear density;

b) dry breaking strength;

c) dry elongation to break;

d) dry elongation at a specified load level;

e) elongation (%) in a reference condition, i.e. a specified tension (specific stress in newtons per tex) and temperature (°C) and time.

These properties shall be documented by test results in accordance with A.4.

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A.2.4 Creep properties

In addition to data in A.2.3 e) above, the following information extracted from a documented model of fibre creep properties based on test results shall be made available by the fibre manufacturer to the rope manufacturer, covering:

a) creep rate (per cent divided by time unit) and allowable extension (%) (or allowable creep time), under a range of specific stresses (N/tex) and temperatures, to cover those expected in operation,

b) creep rate (per cent divided by time unit) under the tension [and corresponding specific stress (N/tex)] and at the temperature (°C) during rope creep test in accordance with Annex C,

c) creep rate in the conditions of fibre testing during production.

NOTE 1 The “creep rate” in this subclause refers to the creep rate in the so-called “steady state creep” regime (see Annex F and Reference [2]).

NOTE 2 Data of creep properties are used by the rope manufacturer (or by the purchaser) to evaluate the creep allowable life time of the rope (see Annex F).

A.3 Fibre test certificate

For each delivery, the fibre manufacturer shall issue a raw material certificate, including, at least, the following information:

a) fibre designation;

b) merge number/batch identification;

c) size (linear density);

d) dry breaking strength;

e) dry elongation to break;

f) creep test (see A.4.2 below).

For acceptance testing, the properties in a) to f) shall be obtained from testing on a representative number of samples taken from the delivery, not less than once every 5 000 kg (and 10 000 kg for creep test only).

For each property, the number of tests, the mean value and the standard deviation or range shall be reported.

A.4 Fibre testing

A.4.1 Fibre linear density and strength

The fibre linear density shall be tested in accordance with ASTM D1907 and ISO 2060.

The fibre strength and elongation shall be determined based on five samples of basic yarn samples taken and tested. These samples shall be conditioned to equilibrium to a temperature of 21 ± 1 °C and a relative humidity of 60 ± 10 %. After conditioning, the samples shall be loaded to break in accordance with ASTM D885, ASTM D2256, ISO 2062 or a documented equivalent method established by the fibre manufacture and derived from existing standards (see Reference [5]). The testing method to be used shall be identified in the rope design documentation. The same method is then to be used whenever the yarn is tested by the fibre manufacturer. The average yarn breaking strength and elongation shall be determined and recorded.

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A.4.2 Creep — Testing of current production

The creep performance of fibre during fibre production shall be verified by testing for measurement of the elongation (per cent per day) in the reference condition given in the fibre specification, i.e. a specified tension (specific stress in newtons per tex) and temperature (°C) and time.

NOTE As an example, the following conditions can be used:

— tension: 0,8 N/tex;

— temperature: 50 °C;

— time: 5 h.

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