
**Steel wire ropes for the petroleum and
natural gas industries — Minimum
requirements and terms of acceptance**

*Câbles en acier pour les industries du pétrole et du gaz naturel —
Exigences minimales et conditions de réception*

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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 document 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).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 105, *Steel wire ropes*.

This second edition cancels and replaces the first edition (ISO 10425:2003), which has been technically revised.

The main changes are as follows:

- tolerance, difference of diameter measurements of compacted strands and compacted (swaged) ropes have been added (see [4.3](#));
- the breaking forces of the more common classes, sizes and grades of compacted strands and compacted (swaged) ropes have been added to the breaking force tables (see [Annex C](#));
- some sizes of well-measuring wire have been added to the diameter tables (see [Annex E](#)).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In recognition of equipment already in use and originally designed to accommodate rope sizes (nominal rope diameters) based on “Imperial” units, some of the more common “converted SI unit” sizes have also been included.

In addition, and in recognition of equipment already in use and designed to operate with ropes having specific rope grades (e.g. IPS), based on “US” wire levels, these grades have also been included in order to give prominence to the required minimum values of breaking force associated with these grades and help to ensure that existing design safety levels are maintained.

Having due regard to size and breaking force for a particular rope class or construction, in some cases it is possible to safely substitute a US customary size and grade with one based solely on SI units and grade, and vice-versa. To assist in this process, this document gives a size range for each nominal rope diameter and equivalent minimum breaking forces (converted from US customary units) for comparison, although it is recommended that the equipment designer or rope manufacturer (or other competent person) is consulted prior to ordering a substitute rope.

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Steel wire ropes for the petroleum and natural gas industries — Minimum requirements and terms of acceptance

1 Scope

This document specifies the minimum requirements and terms of acceptance for the manufacture and testing of steel wire ropes not exceeding rope grade 2160 for the petroleum and natural gas industries.

Typical applications include tubing lines, rod hanger lines, sand lines, cable-tool drilling and clean out lines, cable tool casing lines, rotary drilling lines, winch lines, horse head pumping unit lines, torpedo lines, mast-raising lines, guideline tensioner lines, riser tensioner lines, mooring and anchor lines. Wire ropes for lifting slings and cranes, and wire for well-measuring and strand for well-servicing are also included.

The minimum breaking forces for the more common sizes, grades and constructions of stranded rope are given in tables. However, this document does not restrict itself to the classes covered by those tables. Other types can also conform with its requirements. The minimum breaking force values for these wire ropes are provided by the manufacturer.

For information only, other tables present the minimum breaking forces for large diameter stranded and spiral ropes (i.e. spiral strand and locked coil), while approximate nominal length masses for the more common stranded rope constructions and large diameter stranded and spiral ropes are also given.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2232, *Round non-alloy steel wires for general purpose wire ropes, large diameter wire ropes and mine hoisting wire ropes — Specifications*

ISO 4345, *Steel wire ropes — Fibre main cores — Specification*

ISO 4346, *Steel wire ropes for general purposes — Lubricants — Basic requirements*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

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

ISO 7800, *Metallic materials — Wire — Simple torsion test*

ISO 7989-2, *Steel wire and wire products — Non-ferrous metallic coatings on steel wire — Part 2: Zinc or zinc-alloy coating*

ISO 17558, *Steel wire ropes — Socketing procedures — Molten metal and resin socketing*

ISO 17893, *Steel wire ropes — Vocabulary, designation and classification*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17893 and ISO 7989-2 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 Requirements

4.1 Material

4.1.1 Wire

The wires for stranded ropes and well-servicing strand of carbon steel shall, before fabrication, conform to the diameter, tensile, torsion, and when applicable, coating requirements specified in [Annex A](#).

The methods of test for wires of tensile strength grades 1 370 N/mm², 1 570 N/mm², 1 770 N/mm², 1 960 N/mm² and 2 160 N/mm² shall be in accordance with those given in ISO 2232.

The methods of test for wires of tensile strength grades Levels 2, 3, 4 and 5 shall be in accordance with [Annex B](#).

For those wire ropes where a wire rope grade is applicable, the tensile strength grade of the wires shall be subject to the limits given in [Table 1](#).

NOTE The minimum breaking force values of those wire ropes of grades 1770, 1960 and 2160 as covered by [Tables C.1](#) through [C.24](#) are calculated on the basis of wire rope grade and not individual wire tensile strength grades or levels.

Table 1 — Range of wire tensile strength grades

Rope grade	Wire tensile strength grades N/mm ²
1770 or IPS	1 570 or Level 2 to 1 960 or Level 4
1960 or EIP	1 770 or Level 3 to 2 160 or Level 5
2160 or EEIP	1 960 or Level 4 to 2 160 or Level 5

For those wire ropes (e.g. larger diameter ropes) where a wire rope grade is not applicable, the tensile strength grades of the wires shall be one, or a combination, of those given in [Annex A](#).

All wires of the same nominal diameter in the same wire layer shall be of the same tensile strength grade.

Well-measuring wire and wires used in the manufacture of well-servicing strand shall normally be of carbon steel but other materials (e.g. stainless steel) may be used.

The purchaser should specify any particular material requirements.

4.1.2 Core

Cores of stranded ropes shall normally be of steel or fibre, although other types, such as composites (e.g. steel plus fibres or plastics) or cores made of solid polymer, may also be supplied.

The purchaser should specify the type of core.

Fibre cores shall conform to ISO 4345.

The fibre cores for single-layer stranded ropes larger than 8 mm diameter shall be doubly closed (i.e. from yarn into strand and from strand into rope).

To inhibit rotting and decay, at least one of the following methods shall be adopted for natural fibre cores:

- a) before twisting, the yarn shall be treated with an impregnating compound;
- b) after twisting, the fibre cores shall be treated with an impregnating compound.

Steel cores shall be either an independent wire rope (IWRC) or wire strand (WSC).

Steel cores of single-layer stranded ropes larger than 12 mm diameter shall be an independent wire rope (IWRC), unless specified otherwise.

4.1.3 Lubricant

Lubricants shall conform to ISO 4346.

4.2 Wire rope manufacture

4.2.1 General

In stranded ropes, all the wire layers in a strand shall have the same direction of lay. The lay lengths of corresponding wire layers in strands of the same size, construction and strand layer shall be uniform.

In compacted strand rope, the strands of the same group and layer shall be manufactured by the same compaction processing method.

The core of a stranded rope, except for compacted (swaged) ropes, shall be designed (steel) or selected (fibre) so that in a new wire rope under no load there is clearance between outer strands.

4.2.2 Wire joints

Diameters shall be continuous, but, for wires other than well-measuring wires, if joints are necessary in wires over 0,4 mm they shall have their ends joined by welding.

For stranded ropes, the minimum distance between joints within one strand shall be $18 \times$ wire rope diameter (d).

For spiral ropes, the minimum distance between joints in any wire layer shall be $36 \times$ diameter of the wire layer.

Wires up to and including 0,4 mm may be joined by twisting or by ends being simply inserted into the strands' formation.

4.2.3 Preformation and postformation

Stranded ropes shall be preformed or postformed, or both, unless specified otherwise by the purchaser.

Some parallel-closed ropes and rotation-resistant ropes may be non-preformed.

4.2.4 Construction

The wire rope construction shall be either one of those listed in [Annex C](#) or as stated by the manufacturer.

The constructions of large diameter (i.e. over 60 mm) stranded ropes and spiral ropes (i.e. spiral strand and full-locked coil) shall be stated by the manufacturer.

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Where only the wire rope class is specified by the purchaser, the construction supplied shall be stated by the manufacturer.

For well-servicing strand, the construction shall be either 1 × 16M or 1 × 19M or as stated by the manufacturer.

4.2.5 Rope grade

The wire rope grades for the more common classes and sizes of stranded ropes shall be as given in [Annex C](#).

Intermediate grades may be supplied by agreement between the purchaser and the manufacturer or supplier.

NOTE Not all wire ropes (e.g. large diameter stranded ropes and spiral ropes) will necessarily have a nominated rope grade.

4.2.6 Wire finish

The finish of the wires shall be uncoated (bright) and coated.

For wire ropes of bright wire finish, substitution of bright wires by coated wires shall be limited to inner wires, centre wires, filler wires and core wires.

For wire ropes of coated wire finish, all of the wires shall be coated, including those of any steel core.

Where coating is specified, this may include zinc, zinc alloy and zinc-aluminium alloy.

4.2.7 Direction and type of wire rope lay

The direction and type of wire rope lay for stranded ropes shall be one of the following:

- a) right ordinary lay (sZ);
- b) left ordinary lay (zS);
- c) right lang lay (zZ);
- d) left lang lay (sS);
- e) right alternate lay (aZ);
- f) left alternate lay (aS).

Well-servicing strand shall be left lay (S).

Spiral ropes (i.e. spiral strand and full locked coil) shall be either right (Z) or left lay (S).

NOTE Direction, right(Z) or left(S), is corresponding to the direction of lay of the outer wires in relation to the longitudinal axis of well-servicing strand or a spiral rope.

The direction and type of wire rope lay should be specified by the purchaser.

4.2.8 Designation and classification

For the purposes of this document, the designation and classification systems according to ISO 17893 shall apply.

4.3 Diameter

4.3.1 General

The nominal diameter shall be that by which the wire, strand or wire rope is designated.

4.3.2 Tolerance

When measured in accordance with 5.1.3, the measured (actual) diameter of stranded ropes shall be within the tolerances given in Table 2.

Table 2 — Tolerances on rope diameter (stranded rope)

Type of wire rope	Nominal wire rope diameter d mm	Tolerance as percentage of nominal diameter	
		Wire ropes with strands that are exclusively of wire or incorporate solid polymer centres	Wire ropes with strands that incorporate fibre centres
Conventional strand rope	$2 \leq d < 4$	+8 0	+9 0
	$4 \leq d < 6$	+7 0	+9 0
	$6 \leq d < 8$	+6 0	+8 0
	$d \geq 8$	+5 0	+7 0
Compacted strand rope	$d \geq 8$	+5 0	+6 0
Compacted (swaged) rope	$d \geq 8$	+5 0	+5 0

When measured in accordance with 5.1.3, the measured (actual) diameter of spiral ropes shall be within ${}^{+5}_0$ % of the nominal diameter.

When measured in accordance with 5.1.3, the measured (actual) diameter of well-servicing strand shall be within the tolerances given in Annex D.

4.3.3 Difference between diameter measurements

For stranded and spiral ropes, the difference between any two of the four measurements taken in accordance with 5.1.3 and expressed as a percentage of the nominal diameter shall not exceed the values given in Table 3.

Table 3 — Permissible differences between any two diameter measurements

Type of rope	Nominal wire rope diameter d mm	Wire ropes with strands that are exclusively of wire or incorporate solid polymer centres and spiral ropes %	Wire ropes with strands that incorporate fibre centres %
Conventional strand rope	$2 \leq d < 4$	7	—
	$4 \leq d < 6$	6	8
	$6 \leq d < 8$	5	7
	$d \geq 8$	4	6
Compacted strand rope	$d \geq 8$	4	6
Compacted (swaged) rope	$d \geq 8$	4	6

4.4 Lay length

For single-layer ropes of 6×7 class, the length of lay of the finished wire rope shall not exceed $8 \times$ wire rope diameter (d).

For other single-layer ropes with round strands (except those with three or four strands), parallel-lay closed ropes and rotation-resistant ropes with round strands or shaped strands, the length of lay of the finished rope shall not exceed $7,25 \times$ wire rope diameter (d). For single-layer ropes used in static applications, the length of lay of the finished rope shall not exceed $7,5 \times$ wire rope diameter (d).

For single-layer ropes with shaped strands, e.g. triangular strand, the length of lay of the finished rope shall not exceed $10 \times$ wire rope diameter (d).

For well-servicing strand, the length of lay of the finished strand shall not exceed $10 \times$ strand diameter (d).

4.5 Breaking force

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4.5.1 Well-measuring wire

The minimum breaking force for a given diameter of well-measuring wire shall be as given in [Clause E.1](#).

When tested in accordance with the method specified in [Clause E.2](#), the measured breaking force shall be greater than or equal to the minimum breaking force.

4.5.2 Well-servicing strand

The minimum breaking force for a given diameter and construction shall be either:

- as given in [Annex D](#), or
- as stated by the manufacturer (the value at least in excess of the minimum value given in [Annex D](#)).

When tested in accordance with method 1 (see [5.1.4.1](#)), the measured breaking force shall be greater than or equal to the minimum breaking force.

4.5.3 Stranded ropes and spiral ropes

4.5.3.1 General

The minimum breaking force, F_{\min} , for a given wire rope diameter and construction shall be either:

- as given in [Annex C](#) for stranded ropes, or

b) as stated by the manufacturer (the value at least in excess of the minimum value given in [Annex C](#)).

NOTE 1 Values of minimum breaking force for large diameter stranded and spiral ropes are given for information in [Annex F](#).

For those wire ropes covered in [Annex C](#), the minimum breaking force of intermediate wire rope diameters shall be calculated with the respective minimum breaking force factors in accordance with [Annex G](#).

When tested in accordance with method 1 of [5.1.4.1](#), the measured breaking force, F_m , shall be greater than or equal to the minimum breaking force, F_{min} .

Breaking force testing requirements shall be in accordance with [Table 4](#).

NOTE 2 The requirements for breaking force take into account: (i) the wire rope size; (ii) whether or not wire ropes are produced in series, i.e. repeatedly produced; (iii) whether or not the minimum breaking force factor is consistent throughout a range of diameters; (iv) whether or not the manufacturer is operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body.

4.5.3.2 Wire ropes produced in series — Manufacturer operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body

The manufacturer shall be able to provide the results from type testing in accordance with the sampling and acceptance criteria given in [Annex H](#).

Type testing shall be repeated on any wire rope that has its design changed in any way which results in a modified (e.g. increased) breaking force. Apart from wire tensile strength grades, if the same design is used for wire ropes of a lower grade or lower breaking force, or both, than the one which has successfully passed the type testing requirements, it shall not be necessary to repeat the tests on those wire ropes provided the breaking force is calculated with the same spinning loss.

Subsequent production lengths of wire ropes produced in series shall be deemed to conform to the breaking force requirements when the manufacturer has satisfactorily completed on a sample from every twentieth production length:

- a) the appropriate type tests (see [Annex H](#)), and
- b) a breaking force test in accordance with method 1 or one of the alternative methods, known as methods 2 and 3 (see [5.1.4.2](#) and [5.1.4.3](#)).

Table 4 — Breaking force testing requirements

Wire rope diameter <i>d</i> mm	Min. breaking force factor	Manufacturer operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body	Manufacturer NOT operating a quality system in accordance with ISO 9001, certified by an accredited third party certification body
<i>d</i> ≤ 60	Same factor throughout a sub-group of wire rope diameters	Breaking force test in accordance with 5.1.4.1 (method 1) on a sample from each production length; or, if produced in series, type testing in accordance with H.1.1 plus periodic test in accordance with 5.1.4.1 (method 1), 5.1.4.2 (method 2) or 5.1.4.3 (method 3) on a sample from every twentieth production length relating to the sub-group of diameters.	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length.
	Different factor throughout a sub-group of wire rope diameters	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length; or, if produced in series, type testing in accordance with H.1.2 plus periodic test in accordance with 5.1.4.1 (method 1), 5.1.4.2 (method 2) or 5.1.4.3 (method 3) on a sample from every twentieth production length of a given wire rope diameter and construction.	Breaking force test in accordance with 5.1.4.1 (Method 1) on a sample from each production length.
<i>d</i> > 60		Breaking force test in accordance with 5.1.4.1 (method 1), 5.1.4.2 (method 2) or 5.1.4.3 (method 3) on a sample from each production length, or either of the following: a) if produced in series, type testing in accordance with H.2 plus periodic test in accordance with 5.1.4.1 (method 1), 5.1.4.2 (method 2) or 5.1.4.3 (method 3) on a sample from every twentieth production length; or b) if produced for supply as a set of wire ropes of the same design for a specific installation, the alternative breaking force testing and sampling as also given in H.2.	Breaking force test in accordance with 5.1.4.1 (method 1), 5.1.4.2 (method 2) or 5.1.4.3 (method 3) on a sample from each production length.
NOTE The result from method 1 is known as measured breaking force. The result from method 2 is known as calculated measured (post-spin) breaking force. The result from method 3 is known as calculated measured (pre-spin) breaking force.			

4.6 Length

For those wire ropes not forming part of an assembly, the actual length of wire rope supplied shall be the specified nominal length subject to the following tolerances:

- a) up to and including 400 m: $^{+5}_0$ % of the specified length;
- b) over 400 m, up to and including 1 000 m: $^{+20}_0$ m ;