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Petroleum and natural gas industries — Equipment for well cementing —

Part 1:
Casing bow-spring centralizers

Industries du pétrole et du gaz naturel — Équipement de cimentation de puits —

Partie 1: Centreurs de tubes de cuvelage

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 10427 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10427-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 3, *Drilling and completion fluids, and well cements*.

This first edition of ISO 10427-1 cancels and replaces, in part, the first edition of ISO 10427 (ISO 10427:1993), which has been technically revised.

ISO 10427 consists of the following parts, under the general title *Petroleum and natural gas industries — Equipment for well cementing*:

— *Part 1: Casing bow-spring centralizers*

— *Part 2: Centralizer placement and stop-collar testing*

— *Part 3: Performance testing of cementing float equipment*

Annex A of this part of ISO 10427 is for information only.

This corrected version of ISO 10427-1:2001 has undergone a title change to align with ISO 10427-2 and ISO 10427-3.

Introduction

This part of ISO 10427 is based on API Specification 10D, 5th edition, January 1995.

Users of this part of ISO 10427 should be aware that further or differing requirements may be needed for individual applications. This part of ISO 10427 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this part of ISO 10427 and provide details.

In this part of ISO 10427, where practical, U.S. Customary units are included in brackets after SI units for information.

Petroleum and natural gas industries — Equipment for well cementing —

Part 1: Casing bow-spring centralizers

1 Scope

This part of ISO 10427 provides minimum performance requirements, test procedures and marking requirements for casing bow-spring centralizers for the petroleum and natural gas industries. The procedures provide verification testing for the manufacturer's design, materials and process specifications, and periodic testing to confirm the consistency of product performance.

This part of ISO 10427 is not applicable to rigid or positive centralizers.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 10427. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10427 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 11960, *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells*

3 Terms and definitions

For the purposes of this part of ISO 10427, the following terms and definitions apply.

3.1
flexed
condition of a bow spring when a force three times the specified minimum restoring force (± 5 %) has been applied to it

3.2
holding device
device employed to fix the stop collar or centralizer to the casing

EXAMPLES Set screws, nails, mechanical dogs and epoxy resins.

3.3
holding force
maximum force required to initiate slippage of a stop collar on the casing

3.4
hole size
diameter of the wellbore

3.5
restoring force
force exerted by a centralizer against the casing to keep it away from the wellbore wall

NOTE Restoring force values can vary based on installation methods.

3.6
rigid centralizer
centralizer manufactured with bows that do not flex

3.7
running force
maximum force required to move a centralizer through a specified wellbore diameter

NOTE Running-force values can vary depending on the installation methods.

3.8
standoff
smallest distance between the outside diameter of the casing and the wellbore

3.9
standoff ratio
ratio of standoff to annular clearance

NOTE It is expressed as a percentage.

3.10
starting force
maximum force required to insert a centralizer into a specified wellbore diameter

NOTE Starting-force values can vary depending on the installation methods.

3.11
stop collar
device attached to the casing to prevent movement of a casing centralizer

NOTE A stop collar can be either an independent piece of equipment or integral with the centralizer.

4 Requirements

4.1 Functions of a centralizer

The purpose of a casing centralizer is to facilitate running casing to the desired depth and to assist in centring the casing in the wellbore. One of the main objectives of centralizing a casing string is to facilitate a good cementing, thereby isolating fluids from different zones. A bow-spring centralizer can be constructed in various ways, using various types, shapes and quantities of bow spring.

4.2 Starting force

The maximum starting force shall be less than the weight of 12,19 m (40 ft) of casing of medium linear mass as defined in Table 1. The maximum starting force shall be determined for a centralizer in new, fully assembled condition.

4.3 Restoring force

The minimum restoring force for a 67 % standoff ratio shall not be less than the values shown in Table 1. See A.2 for the derivation of the requirements.

Table 1 — Specifications — Casing centralizers

Casing diameter		Medium linear mass casing		Minimum restoring force at 67 % standoff ratio		Maximum starting force	
mm	(in)	kg/m	(lb/ft)	N	(lbf)	N	(lbf)
89	(3 ½) [a]	14,7	(9,91) [a]	1 761	(396)	1 761	(396)
102	(4) [a]	16,9	(11,34) [a]	2 019	(454)	2 019	(454)
114	(4 ½)	17,3	(11,6)	2 064	(464)	2 064	(464)
127	(5)	19,3	(13,0)	2 313	(520)	2 313	(520)
140	(5 ½)	23,1	(15,5)	2 758	(620)	2 758	(620)
168	(6 $^{5}/_{8}$)	35,7	(24,0)	4 270	(960)	4 270	(960)
178	(7)	38,7	(26,0)	4 626	(1 040)	4 626	(1 040)
194	(7 $^{5}/_{8}$)	39,3	(26,4)	4 697	(1 056)	4 697	(1 056)
219	(8 $^{5}/_{8}$)	53,6	(36,0)	6 405	(1 440)	6 405	(1 440)
244	(9 $^{5}/_{8}$)	59,5	(40,0)	7 117	(1 600)	7 117	(1 600)
273	(10 ¾)	75,9	(51,0)	4 537	(1 020)	9 074	(2 040)
298	(11 ¾)	80,4	(54,0)	4 804	(1 080)	9 608	(2 160)
340	(13 $^{3}/_{8}$)	90,8	(61,0)	5 427	(1 220)	10 854	(2 440)
406	(16)	96,7	(65,0)	5 783	(1 300)	11 565	(2 600)
473	(18 $^{5}/_{8}$)	130,2	(87,5)	7 784	(1 750)	15 569	(3 500)
508	(20)	139,9	(94,0)	8 363	(1 880)	16 725	(3 760)

NOTE The specifications for starting and restoring forces for bow-type centralizers are based on the centralizer being installed as per manufacturer recommendations and tested with lugs on the casing. If the centralizer is tested over a casing collar, stop collar, or with an integral stop collar, the actual results obtained from that test can vary from the specifications. It should be noted on the test report how the centralizer was installed and the type of holding device used during the test. If a centralizer is tested in this manner, the test can no longer be considered a specification test and the results may or may not meet the specifications set forth in Table 1.

[a] Liner sizes and plain-end weight.

4.4 Frequency of testing

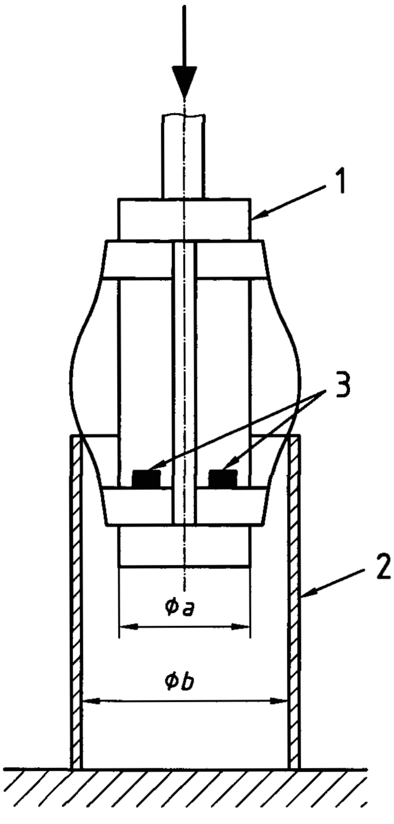
4.4.1 Tests for design and process verification shall be performed for a minimum of six prototype centralizers. All of the tested centralizers shall conform to the performance requirements of Table 1.

4.4.2 For confirmation of the consistency of product performance, testing shall be performed at least annually for each size of centralizer manufactured to this part of ISO 10427 in quantities greater than 500 per year. Corrective action shall be implemented and documented for the centralizer size in question if the tested centralizer does not conform to the performance requirements of Table 1.

5 Testing equipment

5.1 Test stand

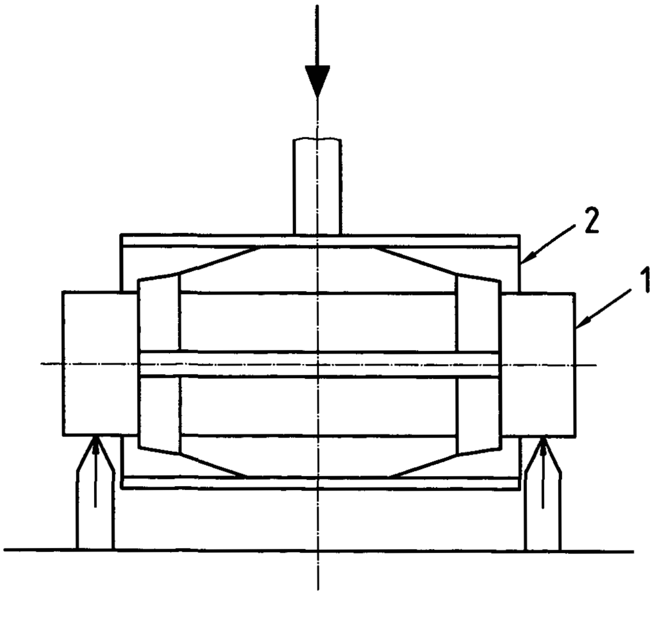
The test stand allows application of vertical loads and is capable of measuring these loads and vertical displacements. Examples of typical equipment are shown in Figures 1 and 2.



Key

1 Inner pipe
2 Outer pipe
3 Equally spaced lugs
a Casing diameter
b Hole diameter

Figure 1 — Example of casing centralizer starting-force test equipment



Key

1 Inner pipe
2 Outer pipe

Figure 2 — Example of casing centralizer restoring-force test equipment

5.2 Instrumentation

Instrumentation of the test stand shall allow displacement readings of 1,6 mm ($^1/_{16}$ in) or smaller.

5.3 Accuracy

5.3.1 Accuracy of load measurements shall be within 5 % of the measured value.

5.3.2 Accuracy of displacement measurements shall be within 0,8 mm ($^1/_{32}$ in).

5.3.3 Calibration of all measuring equipment shall be performed at least annually.

5.4 Test pipe

5.4.1 Inner pipe (see Figures 1 and 2)

The inner pipe shall be longer than the centralizer in the flexed condition and longer than the outer pipe. The outside diameter of the inner pipe shall be within the tolerances shown in ISO 11960 for non-upset pipe. Burrs or similar defects shall be removed.

Surfaces on the ends of the inner pipe, outside the length to be covered by the centralizer and other test components, are exempt from the above requirement.

5.4.2 Outer pipe (see Figures 1 and 2)

The outer pipe shall be longer than the centralizer bow spring in the flexed condition. The inside diameter of the outer pipe shall equal the hole size for which the centralizer is designed. Tolerances shall be within $^{+3,2}_{-0,8}\,\text{mm}\left(^{+1/8}_{-1/32}\,\text{in}\right)$. Burrs or similar defects shall be removed. The upper end of the outer pipe used for the starting-force test may be bevelled on the inside to a maximum of 45°, with a maximum larger-pipe inside diameter of + 3,2 mm (+ $^1/_8$ in).

The end of the outer pipe (other than the upper end used for starting-force tests), beyond the length covered by the centralizer when flexed during the restoring-force test, is exempt from the above requirements.

6 Procedure for starting-force and running-force tests

6.1 Starting-force test

6.1.1 The starting force represents the maximum force required to insert the inner pipe into the outer pipe (after compensating for the weight of the inner pipe and attachments). It is determined as described in 6.1.2 to 6.1.6.

6.1.2 Install a centralizer in new, fully assembled condition as shown in Figure 1 on the inner pipe over four equally spaced lugs, with each lug protruding not more than 6,4 mm ($^1/_4$ in) beyond the outer surface of the inner pipe.

NOTE Under field conditions, there are many different methods of attaching a centralizer to the casing. The starting and restoring forces for all types of holding devices may not be the same as the test results obtained using this procedure.

6.1.3 The test assembly shall be within 5° of vertical.

6.1.4 Lubricate the contacting surfaces with a petroleum-base grease before running the test.

6.1.5 With the centralizer resting on the edge of the outer pipe, apply a load to the inner pipe to pull the centralizer into the outer pipe.

6.1.6 Take readings of force used, from the time the load is first applied until the centralizer is completely inside the outer pipe. Report the maximum force as the starting force after compensation as in 6.1.1.

6.2 Running-force test

6.2.1 The running force represents the maximum force required to slide the inner pipe inside the outer pipe once the force reading has become steady (after compensating for the weight of the inner pipe and attachments).

6.2.2 The result of this test is not required to conform to a maximum value. However, the test shall be performed and the results recorded.

6.2.3 The running-force test may be performed with the starting-force test, or carried out separately.

6.2.4 Take readings of force used from the time the centralizer is inside the outer pipe until the inner pipe is completely in place. Report the maximum force as the running force after compensation as in 6.1.1.

7 Procedure for restoring-force test

7.1 Perform the test with the inner pipe and the outer pipe within 5° of horizontal, see Figure 2.

7.2 Prior to collecting the force data for the test, flex all bow springs 12 times.

7.3 Apply an external force to the outer pipe so that it will be transferred to the inner pipe vertically through the point of contact of the centralizer with the outer pipe, see Figure 2.

7.4 Apply load and record load-deflection readings at a minimum of 1,6 mm ($^{1}/_{16}$ in) increments until three times (± 5 %) the minimum restoring force has been obtained, see Table 1. The travel distance to obtain 67 % standoff shall be determined for each test position.

7.5 Repeat the process, testing the centralizer until each spring and each set of springs has been tested in positions 1 and 2 as shown in Figure 3.

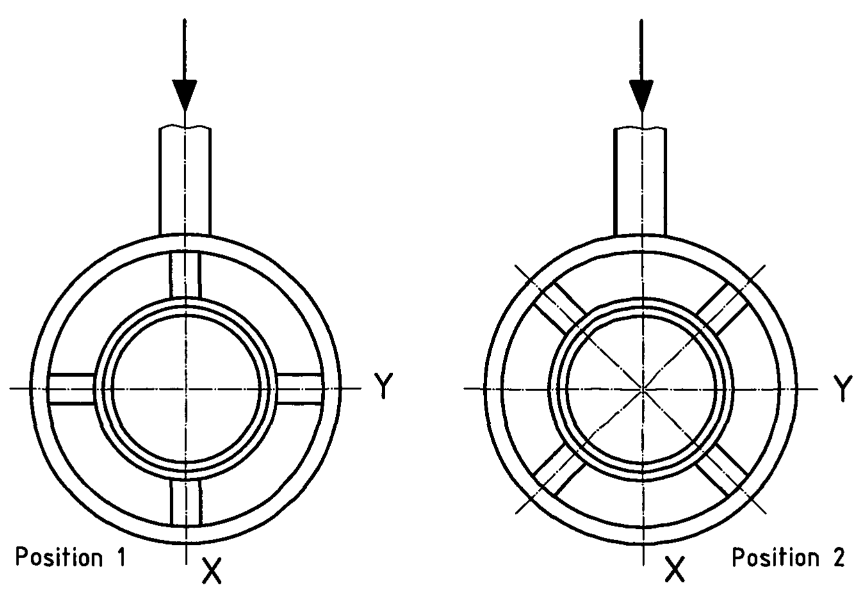


Figure 3 — Casing centralizer test positions

7.6 Calculate the total load at each deflection by compensating for the mass of the travelling pipe and attachments.

7.7 Prepare the final load-deflection curve using the arithmetic average of the force readings at corresponding deflections. Restoring force shall be determined from this curve at 67 % standoff ratio.

8 Marking

8.1 Casing centralizers performing in conformance with this part of ISO 10427 shall be marked by the manufacturer as specified in 8.2.

Additional markings as desired by the manufacturer or as required by the purchaser are not prohibited. The marking shall be die-stamped, paint-stencilled, or adhesive-labelled on the collars or the bow springs.

8.2 The casing centralizers shall be marked with the casing diameter on which to run the centralizers, followed by the hole diameter for which the centralizers were tested to this part of ISO 10427. The marking shall contain the designation ISO 10427-1.

For centralizers shipped pre-assembled, diameter marking may be applied to one bow or collar only. For centralizers shipped disassembled or separate shipments of bows and collars, conformance with this part of ISO 10427 shall be indicated on shipping documents; in this case, shipping documents shall indicate physical identification of respective components.

EXAMPLE A 140 mm (5 ½ in) centralizer meeting the requirements of this part of ISO 10427 in a hole of diameter 200 mm (7 $^{7}/_{8}$ in) shall be marked as follows:

140 mm × 200 mm ISO 10427-1

(or 5 ½ in × 7 $^{7}/_{8}$ in ISO 10427-1 if USC units are used)

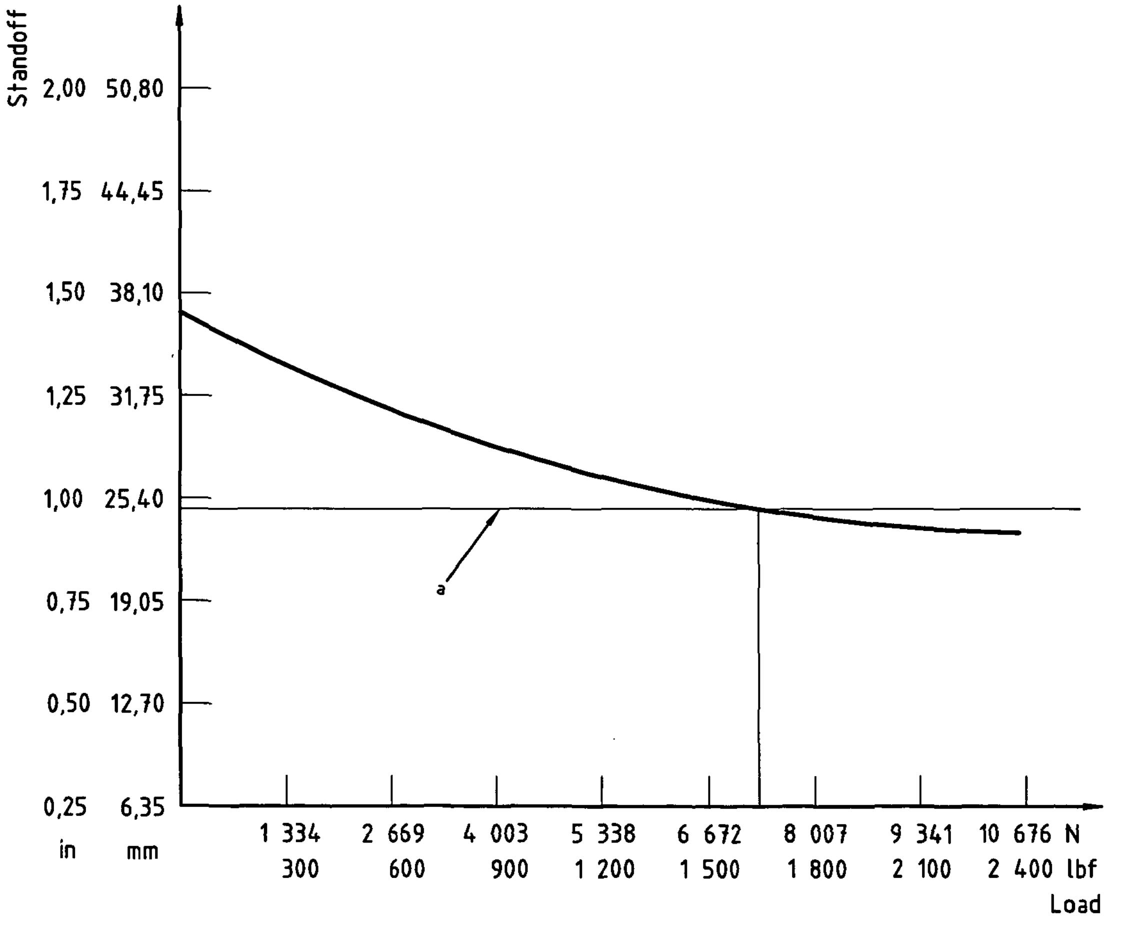
Annex A
(informative)

Miscellaneous information

A.1 Load-deflection information

A typical load-deflection curve is shown in Figure A.1. The curve is prepared using the methods described in clause 7. The purpose of the curve is to provide operators with specific information on the performance of a centralizer in a given hole diameter. This information is useful for determining centralizer spacing in deviated wells.

Load vs. deflection curves may be considered to be proprietary information by the centralizer manufacturer. For this reason, publication of the curves is optional and is not required for compliance with this part of ISO 10427.



Starting force = 2 891 N (650 lbf)

Running force = 1 446 N (325 lbf)

[a] 67 % stand-off

Figure A.1 — Load vs. deflection curve for a 178 mm (7 in) centralizer in 251 mm (9 7/8 in) hole

A.2 Determination of restoring-force requirements

Field observations indicate hole deviation from vertical on an average varies from zero to approximately 60°. Therefore, an average deviation of 30° is used to calculate restoring-force requirements.

For casing diameters 273 mm (10 ¾ in) through 508 mm (20 in), where casing strings are generally placed in relatively vertical hole sections, the minimum restoring force shall be not less than:

$$F_R = W \sin 30 = 0{,}5\ W \quad \text{(A.1)}$$

where

F_R is the minimum restoring force, expressed in newtons;

W is the weight of 12,19 m (40 ft) of medium linear-mass casing, expressed in newtons.

For casing diameters 114 mm (4 $^1/_2$ in) through 244 mm (9 $^5/_8$ in), where casing strings are generally placed in the deviated hole sections, the minimum restoring force shall be not less than:

$$F_R = 2\ W \sin 30 = W \quad \text{(A.2)}$$

A.3 67 % standoff ratio for field applications

The 67 % standoff ratio may or may not give adequate centralization of casing in field applications. The 67 % standoff ratio is used merely for the purpose of specifying minimum performance requirements that centralizers shall meet.

Bibliography

[1] API Spec 10D, *Specification for bow-spring casing centralizers*, fifth edition, January 1995

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