ADDENDUM 3
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# Specification for Rotary Drill Stem Elements

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## ISO 10424-1:2004 (Modified), Petroleum and natural gas industries—Rotary drilling equipment—Part 1: Rotary drill stem elements

AMERICAN PETROLEUM INSTITUTE

# Addendum 3
# Specification for Rotary Drill Stem Elements

*Revise current Sub-Clause* **5.3 Upper and lower kelly valves – connections** *- to read as follows:*

## 5.3 Connections

### 5.3.1 Size and type

All valves covered by this part of ISO 10424, shall be furnished by the manufacturer with end connections for pressure test verification. The preferred end connections on all valves are of the size and style indicated below for the valve type.

Connections stated on the purchase order that are not listed in the tables defined below for each valve type shall be considered as non-preferred (NPC) connections for these applications.

Non-preferred connections are not a part of this specification.

Preferred connections on upper kelly valves shall be of the size and type shown in Clause 6, Column 3 of Table 5 (Table A.5) and Table 7 (Table A.7) of this part of ISO 10424.

Preferred upper connections on lower kelly valves shall be of the size and type shown in Clause 6, Column 7 of Table 5 (Table A.5) and Table 7 (Table A.7) of this part of ISO 10424.

Preferred lower connections on lower kelly valves shall be of the size and type of any connection shown in Table 5 (Table A.5), Table 7 (Table A.7), Table 14 (Table A.14) and Table 23 (Table A.23) of this part of ISO 10424 and including the NC 40 and 6 $^{5}/_{8}$ FH.

Preferred connections on other drill stem safety valves connections shall be of the size and type of any connection shown in Table 5 (Table A.5), Table 7 (Table A.7), Table 14 (Table A.14) and Table 23 (Table A.23) of this part of ISO 10424 and including the NC 40 and 6 $^{5}/_{8}$ FH.

When connections are machined, the corresponding bevel diameters specified for the connection on the joining product shall be used.

Galling of rotary shouldered connections and sealing shoulders occurs frequently in field usage. Treating the shoulders and threads with a coating of zinc or manganese phosphate has proven to be beneficial in lessening this problem. Therefore a treatment of zinc or manganese phosphate shall be applied to the threads and the sealing shoulders of all end connections of kelly valves and other drill stem safety valves manufactured from standard steels. Application of the treatment shall be after completion of all gauging. The treatment type shall be at the discretion of the manufacturer.

Gall-resistant treatments are not readily available for non-magnetic materials, therefore are not required.

Cold working of threads is optional. But purchaser should consider specifying cold working of threads after thread gauging. See 8.1.7.3 for further details.

Consult manufacturer for recommended make-up torques and combined load rating of end connections and any service connections supplied. (See API RP7G Appendix A for combined load rating calculations for API connections.

#### 5.3.2 Non-destructive testing

##### 5.3.2.1 Coverage

End connections and any service connection shall be subjected to non-destructive examination for both transverse and longitudinal defects.

##### 5.3.2.2 Connections from standard steel

Connections manufactured from standard steel shall be examined by the wet magnetic-particle method. The examination shall be preformed according to a written procedure developed by the manufacturer. The procedure shall be in accordance with ISO 9934-1 or ASTM E 709 and shall be made available to the purchaser on request.

##### 5.3.2.3 Connections from non-magnetic material

Connections manufactured from non-magnetic steel shall be examined by liquid penetrant, using the visible or fluorescent solvent-removable or water-washable method. The examination shall be preformed according to a written procedure developed by the manufacturer. The procedure shall be in accordance with ISO 3452 or ASTM E 1209, ASTM E 1219, ASTM E 1220 and ASTM E 1418 and shall be made available to the purchaser on request.

*Revise current Sub-Clause* **5.6 Marking** *to read as follows:*

### 5.6 Marking

Kelly valves and other drill stem safety valves manufactured in accordance with this part of ISO 10424 shall be imprinted using low stress steel stamps or a low-stress milling process as detailed in sub-clauses 5.6.1, 5.6.2 or 5.6.3.

#### 5.6.1 All valves with only preferred end connections

Valves furnished by the valve manufacturer with all connections listed in the tables referenced in sub-clauses 5.3.1.1, 5.3.1.2, 5.3.1.3, 5.3.1.4 or 5.3.1.5 shall be marked with the following information as follows:

a) the manufacturer’s name or mark;

b) “ISO 10424-1” and/or Spec 7-1;

c) date of manufacture (month/year);

d) class of service;

e) unique serial number;

f) the maximum working pressure, to be applied in a milled recess;

g) the connection size and style, applied on the OD surface adjacent to the connection;

h) an indication of the rotational direction required to position valve in the closed position applied on the OD surface adjacent to each valve-operating mechanism;

i) On class 1 type valves, an indication of normal mud flow direction marked with an arrow (→) and the word “flow”.

### 5.6.2 All valves with only one preferred end connection

End connections that are not listed in Table 5 (Table A.5), Table 7 (Table A.7), Table14 (Table A.14), Table 23 (Table A.23), plus the NC 40 and 6 $^5/_8$ FH are considered as Non-Preferred. Non-preferred connections are not a part of this specification.

On upper and lower kelly valves and other drill stem safety valves with only one non-preferred connection (NPC), only the valve body, valve operating mechanism and the preferred connection specified in Table 5 (Table A.5),Table 7 (Table A.7), Table14 (Table A.14), Table 23 (Table A.23), plus the NC 40 and 6 $^5/_8$ FH are covered by this part of ISO 10424.

Marking the valves as stated below certifies that only the valve body, valve operating mechanism and the preferred connections listed in the Tables above meet all the requirements of this part of ISO 10424.

Valves furnished by the valve manufacturer with only one non-preferred connections (NPC) shall be marked with the following information.

a) the manufacturer’s name or mark;

b) “ISO 10424-1” and/or Spec 7-1 as applicable;

c) the letters “NPC”

d) class of service;

e) unique serial number;

f) date of manufacture (month/year);

g) the maximum working pressure, to be applied in milled recess;

h) the connection size and style, applied on the OD surface adjacent to the connection;

i) an indication of the rotational direction required to position valve in the closed position applied on the OD surface adjacent to each valve-operating mechanism;

j) On class 1 type valves, an indication of normal mud flow direction marked with an arrow (→) and the word “flow”.

### 5.6.3 All valves with no preferred end connections

End connections that are not listed in Table 5 (Table A.5), Table 7 (Table A.7), Table14 (Table A.14), Table 23 (Table A.23), plus the NC 40 and 6 $^5/_8$ FH are considered as Non-Preferred. Non-preferred connections are not a part of this specification.

On upper and lower kelly valves and other drill stem safety valves with no preferred connections, only the valve body and the valve operating mechanism are covered by this part of ISO 10424.

Marking the valves as stated below certifies that only the valve body and valve operating mechanism meet all the requirements of this part of ISO 10424.

Valves furnished by the valve manufacturer with no preferred connections shall be marked with the following information.

a) the manufacturer's name or mark;

b) "ISO 10424-1" and/or Spec 7-1 as applicable;

c) the letters "NPC" "NPC" (mark twice);

d) class of service;

e) unique serial number;

f) date of manufacture (month/year);

g) the maximum working pressure, to be applied in milled recess;

h) the connection size and style, applied on the OD surface adjacent to the connection;

i) an indication of the rotational direction required to position valve in the closed position applied on the OD surface adjacent to each valve-operating mechanism;

j) On class 1 type valves, an indication of normal mud flow direction marked with an arrow (→) and the word "flow".

*Revise current Clause* **8.3 Non-magnetic drill collars** *per the following changes and additions*

**8.3.2.1 Tensile requirements**

*Paragraph 4, Second sentence change:*

100 mm (4 in.)

*to*

65 mm (2.6 in.)

*Add note after paragraph 4*

NOTE The mid-wall radius is located a distance below the outside surface equal to the OD divided by 4.

Change current Clause **8.3.3** to be clause **8.3.4**

*Add new Sub - Clauses* **8.3.3, 8.3.3.1, 8.3.3.2, 8.3.3.3, 8.3.3.4** *as follows:*

**8.3.3 Impact strength requirements**

**8.3.3.1 General**

Charpy V-notch impact tests shall be conducted on specimens conforming to the requirements of ISO 148 or ASTM A 370 and ASTM E 23 and shall be conducted at a temperature less than or equal to 24º C (75º F).

#### 8.3.3.2 Specimens

A minimum of one specimen per bar shall be tested, with a minimum of three specimens from each heat. Specimens shall be taken at 25,4 mm (1 in.) below the outside surface or at mid-wall, whichever is closer to the outside surface. The specimen shall be longitudinally oriented and radially notched. (See 8.3.2.1 for definition of mid-wall.)

#### 8.3.3.3 Specimen size

Full size (10 mm × 10 mm) shall be used unless the expected impact energy exceed the calibrated rating of the machine. In this case, sub-size specimens down to half size (10 mm × 5 mm) may be used. The absorbed energy requirement is not changed.

#### 8.3.3.4 Acceptance criteria

The acceptance criteria are listed below. Non-ferrous materials are considered to be those containing less than 50 % iron. For steels, the minimum required impact energy depends on the reported yield strength of the bar being tested.

If the temperature of impact testing is greater than –25° C (–13° F), the average impact strength of all specimens from a heat shall be 120 J (90 ft-lbs) or greater, with no single value less than 100 J (75 ft-lbs).

If the temperature of impact testing is less than or equal to –25° C (–13° F), the average impact strength of all specimens from a heat shall be 40 J (30 ft-lbs) or greater, with no single value less than 33 J (25 ft-lbs).

*Add new Table 31*

**Table 31 — Impact energy of non-magnetic steels**

| Material type | Yield strength range | Minimum impact energy |
|---|---|---|
| Non-magnetic steel | 690 to 970 MPa | 81 J |
| Non-magnetic steel | 970 to 1100 MPa | 68 J |
| Non-magnetic steel | > 1100 MPa | 54 J |
| Non-ferrous alloys | > 690 MPa | 39 J |

*Clause* **8.3.4.1** *(was old sub-clause 8.3.3.1), Paragraph 1, Sentence 4, change definition of one lot to read***:**

One lot is defined as all material from the same heat processed at one time.

*Clause* **8.3.4.2** *(was old sub-clause 8.3.3.2), Paragraph 1, Sentence 3, delete words:*

strip chart

*Re-number current Sub-clause* **8.3.4** *to be* **8.3.5, 8.3.5.1** *and* **8.3.5.2** *and add/revise text as follows:*

### 8.3.5 Corrosion resistance requirements (for austenitic steel collars of 12 % chromium or more)

Austenitic stainless steel collars are subject to cracking due to the joint action of tensile stress and certain specific corrosive agents. This phenomenon is called stress-corrosion cracking.

*Add new sub clause* **8.3.5.1** *and add or revise text as follows:*

### 8.3.5.1 Intergranular corrosion

Resistance to intergranular corrosion shall be demonstrated by subjecting material from each collar to the corrosion test specified in ASTM A 262 Practice E. At the discretion of each supplier, the test specimen may have an axial orientation, in which case it shall be taken from a point at least 25,4 mm (1.0 in.) from the outside surface. Or it may have a tangential orientation, in which case its midpoint shall be at least 25,4 mm (1.0 in.) from the outside surface.

NOTE The midpoint is located a distance below the outside surface equal to the OD/4.

The screening test specified in ASTM A 262, Practice A shall not be waived. The result of the test shall be reported for information.

NOTE The localized corrosion detected by ASTM A 262, Practice A is not an accurate prediction of stress-corrosion cracking, but may be indicative of reduced resistance to severe corrosive environments.

*Add new sub clause* **8.3.5.2** *and add or revise text as follows:*

### 8.3.5.2 Compressive treatment

Under some environmental circumstances, steels may be subject to transgranular stress-corrosion cracking, especially in regions where the manufacturing process creates tensile residual stress. Drill collars made of austenitic steel bars containing 12 % to 30% chromium shall be treated on the inside surface to generate a layer of compressive residual stress at least 1 mm (0,040 in) deep as measured by ASTM E837.

*Revise Table 18 as follows:*

**Table 18 — Mechanical properties for new non-magnetic drill collars**

| **Drill collar OD range**<br>mm | **Yield Strength**<br>MPa<br>min. | **Tensile Strength**<br>MPa<br>min. | **Elongation stainless steel collars**<br>%<br>min. | **Elongation non-ferrous collars**<br>%<br>min. |
|---|---|---|---|---|
| 70 through 98,4 | 827 | 896 | 16 | 13 |
| 101,6 through 174,6 | 758 | 827 | 18 | 13 |
| 177,8 through 279,4 | 689 | 758 | 20 | 13 |

*Change current clause* **8.3.5** *to* **8.3.6**.

*Add the following new Clause* **12***.*

# 12 Stabilizers

## 12.1 General

This Clause applies to String Stabilizers and Near-bit Stabilizers, with either Integral-Body or Welded-Blade construction. The important dimensions of stabilizers are defined in Figure 12.

## 12.2 Definitions

**12.2.1**
**stabilizer (blade) diameter**
diameter at largest cross section

**12.2.2**
**wrap angle**
total angular extent of full blade diameter, summed across all blades

**12.2.3**
**crown length**
axial extent of full blade diameter (except as noted in Figure 15 for watermelon profile)

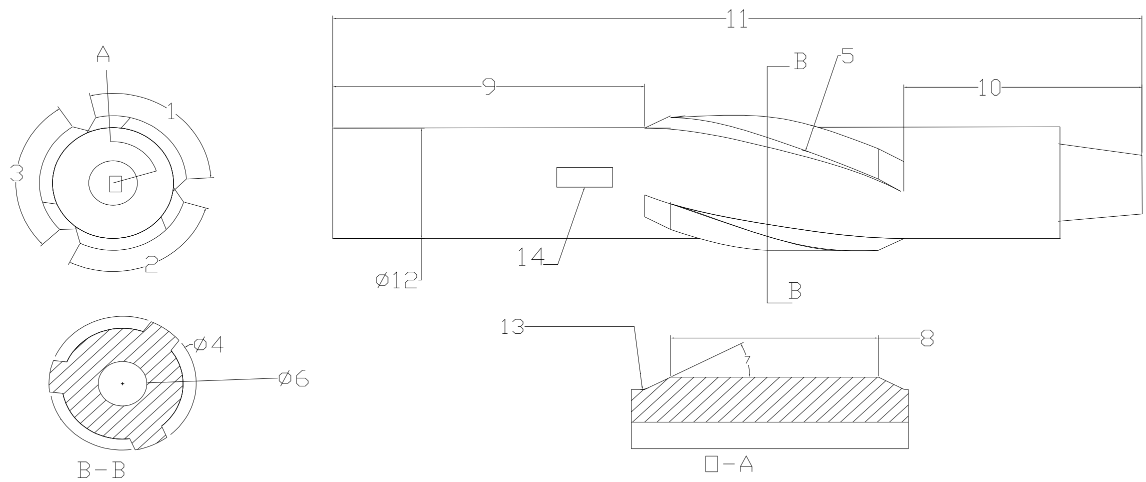
**12.2.4**
**neck**
region at upper and lower end of stabilizer containing connections

**12.2.5**
**blade**
enlarged region intended to make contact with the borehole

**12.2.6**
**core**
the continuous member of a welded-blade stabilizer

**12.2.7**
**integral-blade stabilizer**
stabilizer made from single piece of material

**12.2.8**
**welded-blade stabilizer**
stabilizer made from welding blades to a core




**Key**

1 + 2 + 3 Wrap angle
4 Blade diameter
5 Blade width
6 Inside diameter
7 Blade taper angle
8 Crown length
9 Upper neck length
10 Lower neck length
11 Overall length
12 Neck diameter
13 Radius, 25 mm (1 in.) minimum, 2 places
14 Marking recess

**Figure 12 — Measurement Definitions for Stabilizers**

## 12.3 Material requirements

### 12.3.1 General

Stabilizers may be made from standard steel or non-magnetic stainless steel. Standard steel shall be used unless non-magnetic material is specified. Integral-body stabilizers or the core of welded-blade stabilizers made from standard steel shall be quenched and tempered full-length.

### 12.3.2 Neck regions

#### 12.3.2.1 Tensile requirements

The neck regions of an integral stabilizer, and the core of a welded-blade stabilizer shall have tensile properties equal to those of drill collars of the same size, as detailed in Table 17 (Table A.17) or Table 18 (Table A.18) of this specification.

#### 12.3.2.2 Impact energy requirements

The neck regions shall also meet the impact energy requirement of Sub-clauses 8.2.1.3 or 8.3.3 of this specification.

Testing of standard steel stabilizers is required on each heat per heat treatment lot.

#### 12.3.2.3 Special testing requirements of integral stabilizers

For an integral-blade stabilizer, the tensile and impact specimens shall be taken from a prolongation of either neck, with the center of the specimen at least 100 mm (4 in.) from a free end, and at least 25 mm (1 in.) below the finished surface of the neck as shown in Figure 13. The prolongation shall be the same diameter as the neck at the time of heat treatment. The uniform region shall extend for at least 400 mm (16 in.) from each end of the finished stabilizer, or to within 25 mm (1 in.) of the stabilizer blades, whichever is less, as shown in Figure 13. The extent of the area of controlled properties shall be verified by Brinell hardness testing, with a minimum hardness of 285 HBW.

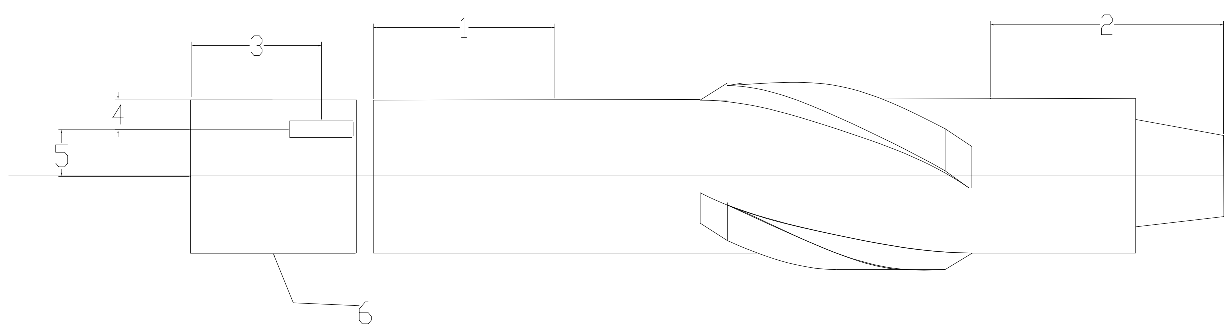
When standard steel material is heat-treated as a forging or bar, without knowledge of the final neck diameter, the sampling location shall be determined by the largest diameter of the forging, or the diameter of the bar.

In all cases, the radius of the sample location shall be reported.

**Table 32 — Sampling requirements**

All dimensions are in millimeters

| Maximum Diameter of forging or bar | Radius of Sampling in neck region |
|---|---|
| < 188 | 35 |
| 189 to 245 | 57 |
| 248 to 508 | 76 |
| >508 | 89 |




**Key**

1, 2 Zone of uniform hot working heat treatment or warm forging
3 Distance from end of forging or bar for mechanical sample
4 Depth below surface of finished neck for mechanical sampling
5 Radius of sampling for forging or raw bar
6 Prolongation

**Figure 13 — Sampling locations**

#### 12.3.2.4 Traceability

The manufacturer shall establish and follow procedures for maintaining material identity. The methods of maintaining identity shall be at the option of the manufacturer. These procedures shall provide means for tracing the stabilizer body to the relevant heat, chemical analysis report, and specified mechanical test results.

#### 12.3.3 Body regions

An integral-blade stabilizer shall be machined from a single piece of material. The core and necks of a welded-blade stabilizer shall be machined from a single piece of material. The material shall be inspected for defects according to Clause 11 of this specification and shall meet the acceptance criteria as defined therein. Mechanical testing shall only be required for the neck region as defined above.

### 12.4 Blade Welding

For welded-blade stabilizers, there shall be a documented welding procedure (WPS and PQR) for the welding of blades to the stabilizer core, and welders or welding machines shall have documented qualification (WQR) to this procedure. The welds shall be inspected using a documented procedure of Non-Destructive Evaluation.

NOTE Transverse welding at the ends of blades is not recommended.

### 12.5 Abrasion protection

The crown surface of the stabilizer shall be provided with protection against abrasion. The protection method is optional to the manufacturer unless specified by the purchaser and is outside the scope of this standard. However, a documented procedure for applying this protection shall exist (WPS for welded hard-facing), and welders or welding machines shall have documented qualification (WQR) to this procedure.

### 12.6 Dimensional requirements

The following dimensional requirements apply to all stabilizers covered by this standard.

#### 12.6.1 Neck length

The length of upper and lower necks shall be as indicated in Table 33 (Table A.33)

**Table 33 — Neck lengths**

All dimensions in millimeters

| Location | Minimum lengths |
|---|---|
| Upper Neck | 760 |
| Lower Neck, String stabilizer | 600 |
| Lower Neck, Near-bit stabilizer | 450 |

#### 12.6.2 Neck diameters

Upper and lower neck diameter shall be as described in Table 34 (Table A.34). Tolerances shall be the same as those defined for drill collars in Table 15 (A.15)

**Table 34 — Neck diameters and connections**

All dimensions are in millimeters

| Neck Diameter | Connection, Box x Pin | Box Connection, Near Bit Stabilizer lower | Inside Diameter | Blade Diameter |
|---|---|---|---|---|
| 121 | NC38 | 3-1/2 REG | 51 | 130 to 187 |
| 165 | NC46 | 4-1/2 REG | 71 | 191 to 200 |
| 171 | NC50 | 4-1/2 REG | 71 | 203 to 244 |
| 203 | 6-5/8 REG | 6-5/8 REG | 71 | 241 to 394 |
| 203 | 6-5/8 REG | 7-5/8 REG | 71 | 397 to 508 |
| 241 | 7-5/8 REG | 7-5/8 REG | 76 | 311 to 508 |
| 241 | 7-5/8 REG | 7-5/8 REG | 76 | 397 to 660 |
| 241 to 279 | 7-5/8 REG | 8-5/8 REG | 76 | 508 to 660 |
| 279 | 8-5/8 REG | 8-5/8 REG | 76 | >660 |

### 12.6.3 Blade Dimensions

The blade diameter, length and number shall be as indicated in Table 35 (Table A.35).

**Table 35 — Blade dimensions**

All dimensions are in millimeters

| **Up-hole and downhole blade taper angles**[a] | 30 ± 5 degrees integral | | | | | |
|---|---|---|---|---|---|---|
| | 30-45 degrees welded | | | | | |
| **Blade diameter** +0/–0,8 | 130 to 187 | 191 to 244 | 245 to 311 | 318 to 394 | 397 to 508 | >508 |
| **Number of Blades, Integral** | 3 | 3 | 3 | 3 | 3 | 3 |
| **Number of Blades, Welded** | 3 | 3 | 3 or 4 | 3 or 4 | 3 or 4 | 4 |
| **Blade width (integral) ± 6** | 51 | 64 | 76 | 89 | 102 | 102 |
| **Blade width (welded) ± 6** | 38 | 51 | 51 | 64 | 76 | 76 |
| **Crown length min (see note)** | 305 | 406 | 457 | 457 | 508 | 508 |

NOTE The crown may be tapered at customer's option to form a "watermelon geometry" as in Figure 15. The crown length includes the length of this shallow taper

a The taper angle requirement applies only for the first 25 mm radially from the blade surface. If the blade height exceeds 25 mm, the taper angle for the remainder of the height may be up to 45 degrees at the manufacturer's discretion. See Figure 14.

### 12.6.4 On gauge blade diameter

For a gauge stabilizer, the blade diameter shall be defined using a ring gauge of the same dimensions as the bit Not-Go gauge of Sub-clause 9.2.3.1 for the given nominal diameter. Other measuring methods may be used, with the ring gauge as arbiter in case of dispute.

The diametrical clearance to this gauge shall be 0 mm to 0,76 mm (0 in. to 0.03 in.)

### 12.6.5 Blade spiral

The spiral shall be as defined on the purchase order, and interpreted according to Table 36. Unless otherwise specified, the spiral shall be right-hand.

**Table 36 — Blade spiral definitions**

| Spiral Description | Wrap Angle (see Figure 12) |
|---|---|
| Straight blade | Not applicable |
| Open spiral | 180 – 220 degrees |
| Full spiral | 300 – 350 degrees |
| Tight Spiral | 500 – 600 degrees |

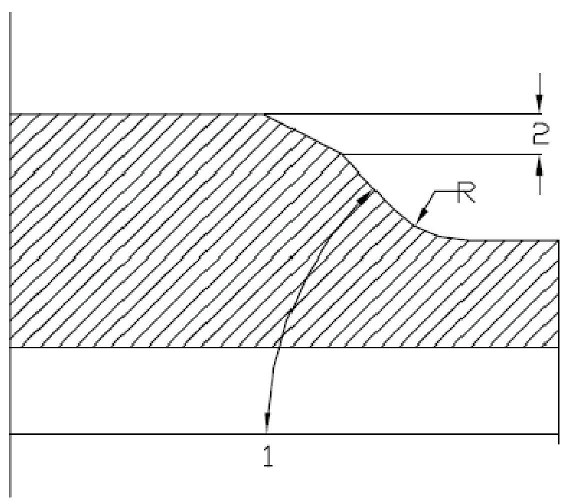
## 12.7 Connections and bevel diameters

### 12.7.1 Size and type

The connections shall be as described in Table 34 (Table A.34). The bevel diameters for the upper connection of all stabilizers, and for the lower connection of string stabilizers shall be the same as those defined in Table 14 (Table A.14). The bevel diameter for the lower connection of near-bit stabilizers shall be as defined in Table 19 (Table A.19).

### 12.7.2 Gall Resistant Treatment for Threads and Sealing Shoulders

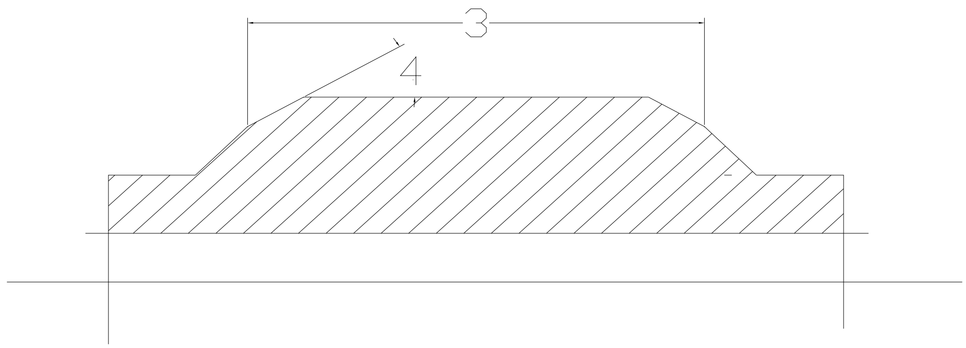
For standard steel stabilizers, a gall-resistant treatment of zinc or manganese phosphate shall be applied to the threads and sealing shoulders of both the upper and lower connections. Application of the treatment shall be after completion of all gauging. The treatment type shall be at the discretion of the manufacturer.




**Key**

1 Increased taper angle
2 Depth to start of increased taper angle

**Figure 14 — Blade taper geometry**




**Key**

3 Crown length definition for watermelon geometry
4 Typical crown taper of watermelon geometry

**Figure 15 — Watermelon geometry**

## 12.8 Customer information

### 12.8.1 Required information from customer

a) Stabilizer type: String or near-bit

b) Integral or welded

c) Stabilizer (blade) diameter

d) Wrap: Tight Spiral, Full Spiral, Open Spiral or Straight

e) Neck size and connections

### 12.8.2 Optional requirements

a) Connection Stress Relief features, per ISO 10424-2 (API Spec 7-2)

b) Connection cold working

c) Connection surface treatment (optional for non-magnetic only)

d) Non-magnetic

e) Abrasion protection type

f) Left hand spiral

g) Float valve recess on near-bit stabilizer

## 12.9 Marking

The following information shall be marked on a marking recess with steel stamps or milled lettering a minimum of 6 mm (0.25 in.) in height. This recess shall be located on the upper neck, as shown in Figure 1 within 100 mm (4 in.) of the stabilizer blades.

a) Manufacturer name or mark.

b) Blade diameter (add – “NM” for a non-magnetic stabilizer).

c) ISO 10424-1 and/or API Spec 7-1.

d) Upper Connection size and style.

e) Internal diameter.

f) Serial number.

g) Lower Connection size and style.

Examples:

A 447,7 mm (17 $^{5}/_{8}$ in.) stabilizer, with 76 mm (3 in.) bore, manufactured by A B Company, shall be stamped:

A B Co. (or mark) 447,7 (17 $^{5}/_{8}$) ISO 10424-1 and/or API Spec 7-1 6 $^{5}/_{8}$ REG 76 (3) Serial No. 6 $^{5}/_{8}$ REG

A 209.5.mm (8 $^{1}/_{4}$ in.) Non-magnetic stabilizer, with 71,4 mm (2 $^{13}/_{16}$ in.) bore, manufactured by A B Company, shall be stamped:

A B Co. (or mark) 209,5 (8 $^{1}/_{4}$) NM ISO 10424-1 and /or API Spec 7-1 NC50 71,4 (2 $^{13}/_{16}$) Serial No. NC50

# Annex A
(informative)

# Tables in US Customary units

*Revise Table A.18 to Annex A to read as follows:*

**Table A.18 — Mechanical properties for new non-magnetic drill collars**

| Drill collar OD range<br>in. | Yield Strength<br>psi<br>min. | Tensile Strength\<br>psi<br>min. | Elongation stainless steel collars<br>%<br>min. | Elongation non-ferrous collars<br>%<br>min. |
|---|---|---|---|---|
| 2 3/4 through 3 7/8 | 120 000 | 130 000 | 16 | 13 |
| 4 through 6 7/8 | 110 000 | 120 000 | 18 | 13 |
| 7 through 11 | 100 000 | 110 000 | 20 | 13 |

*Add the following new tables to* **Annex A**:

**Table A.31 — Impact energy of non-magnetic steels**

| Material type | Yield strength range | Minimum impact energy |
|---|---|---|
| Non-magnetic steel | 100 000 – 140 000 psi | 60 ft-lbs |
| Non-magnetic steel | 140 000 – 160 000 psi | 50 ft-lbs |
| Non-magnetic steel | > 160 000 psi | 40 ft-lbs |
| Non-ferrous alloys | > 100 000 psi | 30 ft-lbs |

**Table A.32 — Sampling requirements**

All dimensions are in inches

| Maximum Diameter of forging or bar | Radius of Sampling in neck region |
|---|---|
| < 7 3/8 | 1 3/8 |
| 7 3/8 to 9 5/8 inclusive | 2 1/4 |
| 9 3/4 to 20 inclusive | 3 |
| >20 | 3 1/2 |

**Table A.33 — Neck lengths**

All dimensions are in inches

| Location | Minimum lengths |
|---|---|
| Upper Neck | 30 minimum |
| Lower Neck, String stabilizer | 24 minimum |
| Lower Neck, Near-bit stabilizer | 18 minimum |

## Table A.34 — Neck diameters and connections

All dimensions are in inches

| Neck Diameter | Connection, Box x Pin | Connection, NBS lower | Inside Diameter | Blade Diameter |
|---|---|---|---|---|
| 4 3/4 | NC38 | 3-1/2 REG | 2 | 5 1/8 to 7 3/8 |
| 6 1/2 | NC46 | 4-1/2 REG | 2 13/16 | 7 1/2 to 7 7/8 |
| 6 3/4 | NC50 | 4-1/2 REG | 2 13/16 | 8 to 9 5/8 |
| 8 | 6-5/8REG | 6-5/8 REG | 2 13/16 | 9 1/2 to 15 1/2 |
| 8 | 6-5/8 REG | 7-5/8 REG | 2 13/16 | 15 5/8 to 20 |
| 9 1/2 | 7-5/8 REG | 7-5/8 REG | 3 | 12 1/4 to 20 |
| 9 1/2 | 7-5/8 REG | 7-5/8 REG | 3 | 15 5/8 to 26 |
| 9 1/2 to 11 | 7-5/8 REG | 8-5/8 REG | 3 | 20 to 26 |
| 11 | 8-5/8 REG | 8-5/8 REG | 3 | >26 |

## Table A.35 — Blade dimensions

All dimensions are in inches

| Up-hole and downhole blade taper angles[a] | 30 ± 5 degrees integral | | | | | |
|---|---|---|---|---|---|---|
| | 30 - 45 degrees welded | | | | | |
| **Blade diameter (in.)** +0/–1/32 | 5 1/8 to 7 3/8 | 7 1/2 to 9 1/2 | 9 5/8 to 12 1/4 | 12 3/8 to 14 5/8 | 14 3/4 to 20 | >20 |
| **Number of Blades Integral** | 3 | 3 | 3 | 3 | 3 | 3 |
| **Number of Blades Welded** | 3 | 3 | 3 or 4 | 3 or 4 | 3 or 4 | 4 |
| **Blade width (integral) ± .25** | 2 | 2.5 | 3 | 3.5 | 4 | 4 |
| **Blade width (welded) ± .25** | 1.5 | 2 | 2 | 2.5 | 3 | 3 |
| **Crown length min ( see note)** | 12 | 16 | 18 | 18 | 20 | 20 |

NOTE The crown also may be tapered at customer's option to form "watermelon geometry" as in Figure 4. The crown length includes the length of this shallow taper.

a The taper angle requirement applies only for the first 1 in. radially from the blade surface. If the blade height exceeds 1 in., the taper angle for the remainder of the height may be up to 45 degrees at the manufacturer's discretion. See Figure 14.

## Table A.36 — Blade spiral definitions

| Spiral Description | Wrap Angle (see Figure 12) |
|---|---|
| Straight blade | Not applicable |
| Open spiral | 180 – 220 degrees |
| Full spiral | 300 – 350 degrees |
| Tight Spiral | 500 – 600 degrees |

*Add the following new* **Annex C.**

# Annex C
(informative)

# Summary of Product Specification Level (PSL) requirements

## C.1 General

Certain tools are often used in the drill stem that are not directly covered by this international standard. To help the user insure these tools will provide a minimum level of performance, this annex is provided to identify additional requirements when products are ordered to PSL – 1 which defines the material property.

## C.2 Large cross section specialty tools

These tools have a major diameter greater than 280 mm (11 in.) or tools with a change of 75 mm (3 in.) or more in outside diameter over the length of the tool and are not covered elsewhere in this international standard.

## C.3 Material heat treatment

### C.3.1 Low alloy steel

Tools manufactured from low-alloy steels shall be quenched and tempered. The heat treating process may be either batch or continuous. All testing shall be performed after final heat treatment.

If the starting material is bar stock that has been heat treated full length and has been tested at a depth equal to or greater than the depth at the critical location (see sub-clause C.4) and meets the required mechanical properties, the material may be used without further heat treating.

If the material does not meet the required mechanical properties at the critical location, the material shall be heat treated and tested after final heat treatment. The mechanical test specimens shall be removed from a prolongation, a sacrificial part or a qualification test coupon (QTC) as described below to verify the tensile, yield, impact and hardness properties at the critical location. Material may be rough machined prior to heat treating.

### C.3.2 Non-magnetic materials

Non-magnetic materials shall be solution annealed and cold or warm worked. All testing shall be performed after solution annealing and cold or warm working.

## C.4 Critical locations

Critical locations are areas on the part where the stresses from service loads are the highest. These locations are the most likely locations for in-service failures. The product designer shall be responsible for identifying the critical location in the product design. The manufacturer shall be responsible for verifying that the mechanical properties are met at the critical location.

## C.5 Mechanical test specimens

For heat treated material, either batch or continuous, the mechanical test specimen shall be removed from a sacrificial production part, or from a prolongation removed from a production part, or from a Quality Test Coupon (QTC) from the same heat.

When required, the product designer may specify that the test specimen shall come from a sacrificial production part, or from a prolongation removed from a production part, or if a Quality Test Coupon (QTC) is to be used. If not specified by the product designer, the choice shall be at the discretion of the manufacturer.

## C.5.1 Sacrificial production part

If a sacrificial production part is used to obtain the test specimens, it shall only be used to qualify parts that have the same dimensions at the time of heat treating and are of the same heat of material. The specimens shall be removed from the critical location identified in the part design.

## C.5.2 Prolongation

If the test specimens are to be taken from a prolongation of a production part, the prolongation shall have the same dimensions as the critical location identified in the part design and shall be long enough so the test specimens are located no closer than one-half radius to a heat treated end.

## C.5.3 Qualification test coupon (QTC)

A QTC is a separate test coupon from the same heat of material as the production part and shall be heat treated in the same lot as the production part. The purpose of the QTC is to provide representative mechanical properties of the part being qualified. The geometry of the QTC shall be selected so that the heat treat response of the QTC simulates the heat treat response of the critical location of the part it qualifies. This is accomplished using the ER method described in sub-clause C.5.3.1. A hollow QTC shall only be used if the production part is hollow at the time of heat treatment.

Depending on the hardenability of a given material, the QTC results may not always correspond with the properties of the actual components at all locations throughout their cross-sections.

### C.5.3.1 ER Method

Most available data on heat treatment refers to round sections. If the production parts are not round at the critical location, the geometry at the critical location can be visualized as simple shapes such as squares, hexagons, plates or tubes that can be equated to an equivalent round (ER). The equivalent round has essentially the same cooling rate as the simple shape and the same response to heat treatment, so a QTC based on the ER of the critical location can be used to verify the mechanical properties.

The method used to determine the diameter of the equivalent round shall be in accordance with the technique outlined in SAE-AMS H-6875.

The ER of a part shall be determined using the actual dimensions of the part at the critical location and in the "as heat treated" condition.

The ER of a part has the same cross sectional area as the simple shape it replaces when the dimension "T" is the thickness of the part.

The ER of the QTC shall be equal to or greater than the dimensions of the part it qualifies.

The ER is the diameter of the equivalent round that replaced the simple shape.

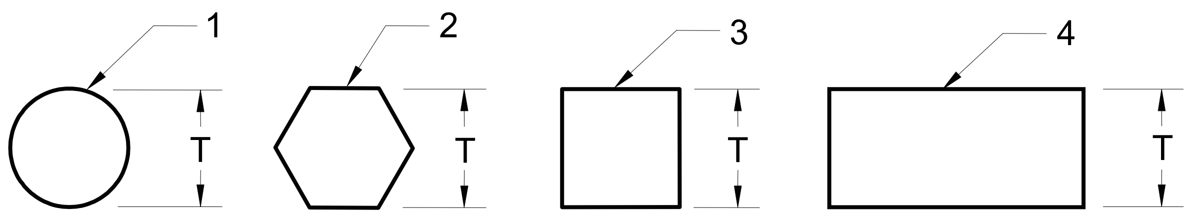
The length of the QTC shall not be less than the calculated diameter of the ER.

The QTC shall only qualify production parts whose critical sections have the same or a smaller ER.

The total hot work ratio for the QTC shall not exceed the total hot work ratio of the part(s) it qualifies. The hot work ratio is the area ratio of the cast diameter and the pre-machined finished diameter.

Figure B.1 illustrates the basic models for determining the ER of simple solid shapes.

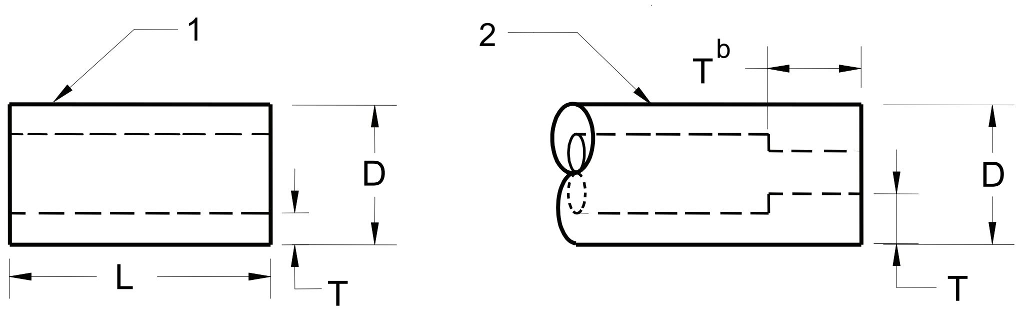
Figure C.2 illustrates the basic models for determining the ER of simple hollow parts and hollow parts with more complicated shapes.




**Key**

1 round [a] ER [b] = 1.0 T
2 hexagonal [a] ER = 1.1 T
3 square [a] ER = 1.25 T
4 rectangular [a] or plate ER = 1.5 T
[a] when "L" is less than "T", treat the section as a plate of "L" thickness
[b] ER = equivalent round

**Figure C.1 — Correlation between significant dimensions of simple solid shapes of length "L" to the diameters of round bars**




**Key**

1 Tube open both ends [a] ER [b] = 2 T
2 Tube restricted or closed at one or both ends
ER = 2.5 T when D is less than 2.5 inches
ER = 3.5 T when D is greater than 2.5 inches
[a] when "L" is less than "D", treat as a plate of "T" thickness.
when "L" is less than "T", treat section as a plate of "L" thickness.
[b] ER = equivalent round

**Figure C.2 — Correlation between the significant dimensions of simple hollow parts and hollow parts with more complicated shapes to the diameters of round bars**

## C.6 Mechanical test requirements

Tensile, hardness and impact specimens shall be removed from sacrificial parts, or prolongations or a QTC after the final heat treatment cycle. When tensile, hardness or impact tests are taken from sacrificial parts or prolongations, the tests shall be at a depth that corresponds to the critical location of the finished part. When a solid QTC is used to verify mechanical properties, the test specimen shall be removed so that the longitudinal axis of the specimens is at a depth equal to or greater than 1/4 T. If a hollow QTC is used, the test specimens shall be removed so that the longitudinal axis of the specimens is located mid-wall of the QTC.

Location of the mid wall from the outside surface of the hollow QTC can be found by the following formula:

$$\text{Mid-wall} = (OD - ID)/4$$

where

$OD$ is the outside diameter of the QTC

$ID$ is the inside diameter of the QTC at its thickest section

### C.6.1 Tensile testing

The standard size 12,5 mm (0.500 in.) diameter round test specimen conforming to the requirements of ISO 6892 or ASTM A370 shall be used for tensile testing, unless the physical configuration prevents their use. If the standard size specimen can not be used, the next smaller sub-sized specimens shall be used. Yield strength shall be determined by tests on cylindrical specimens conforming to the requirements of ISO 6892 or ASTM A370, 0.2% offset method.

### C.6.2 Hardness testing

At least one Brinell hardness test shall be performed on the surface of each production part after the final heat treatment cycle. A Brinell hardness test is required on the surface of the QTC if a QTC is used to verify mechanical properties. A Brinell hardness test is also required at the location where the specimens are taken for the tensile and impact tests.

### C.6.3 Impact strength testing

Charpy V-notch impact tests shall be conducted at a temperature of 21° C ± 3° C (70° F ± 5° F). Tests conducted at lower temperatures that meet the absorbed energy requirements are acceptable.

The standard size 10 mm × 10 mm(0.394 in. × 0.394 in.) test specimen conforming to the requirements of ISO 6892 or ASTM A370 shall be used for impact testing, unless the physical configuration prevents their use. If the standard size specimen can not be used, the next smaller sub-sized specimens shall be used.

If it is necessary to use sub-size impact specimens, the acceptance criteria shall be multiplied by the appropriate adjustment factor listed in Table 2 in Sub clause 5.2.3.3. Sub-size test specimens of width less than 5 mm (0.197 in.) shall not be permitted.

One set of 3 specimens shall be tested.

### C.6.4 Acceptance criteria for tensile, yield, elongation, impact and hardness

The mechanical properties of the critical section of the part shall comply with the requirements of Table C.1.

**Table C.1 — Mechanical properties and tests for heavy section tools**

| **Yield strength MPa (psi) minimum** | **Tensile strength MPa (psi) minimum** | **Elongation, with Gauge length four Times diameter % minimum** | **Impact strength Joules (ft-lbs)** | | Brinell hardness HBW |
|---|---|---|---|---|---|
| | | | **Average 3 specimens** | **Minimum single specimen** | |
| 689 (100,000) | 758 (135,000) | 13 | 54J (40) | 47J (37) | 277 - 352 |

*In clauses* **8.1.7.1.2**, **8.1.7.2**, **8.1.7.3**, *and* **8.1.7.4**; *change* Spec 7 *to* Spec 7-2.

*In clauses* **6.6**, **7.6**, *and* **8.1.6**; *change* Clause 10 *to* Clause 11.

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