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Affected Publication: API Specification 7-1, Rotary Drill Stem Elements, 2nd Edition, February 2023

ADDENDUM 1

1.0 The section title shall be changed to the following:

1 Scope

This standard specifies the technical delivery conditions for rotary drill stem elements: upper and lower kelly valves, square and hexagonal kellys, drill stem subs, drill collars (steel and non-magnetic, round, and spiral), heavy-weight drill pipe (HWDP), drilling and coring bit connections, and stabilizers.

This standard is not applicable to drill pipe and tool joints, rotary shouldered connection designs, thread gauging practices, or grand master, reference master and working gauges, and does not include or identify performance properties. A typical drill stem assembly applicable to this standard is provided (see 4.1, Figure 1).

Coring bits, percussion bits, and bits for hole enlargement (hole openers and reamers) are not covered by this standard.

3.1. The following definitions shall be added, and the section shall be subsequently renumbered:

drill bit

Bottom-most element of the drill string equipped with a cutting structure to penetrate rock and drill the hole.

NOTE 1 A drill bit may include the full cross section of the hole (regular bit) or an annulus (coring bit).

NOTE 2 Regular bits include fixed cutter, roller cone, and diamond.

fixed cutter (FC) bits

Bits that have a threaded connection on one end and several fixed blades with cutting elements to drill the rock formation.

NOTE PDC (polycrystalline diamond compact) bits represent most FC bits, by virtue of their long life and high drilling rates, with no moving parts and cutting action that involves shearing the formation – which is the most efficient way to drill since the shear strength for rock is generally much lower than the compressive strength.

roller cone (RC) bits

Bits that have a threaded connection on one end and usually three cones to drill the rock formation.

NOTE RC bit cutting action involves gouging and scraping the formation, so higher weight-on-bit levels are commonly employed, with resulting lower drilling torques and rates of penetration.

8.3.4 The section title shall be changed to the following:

8.3.4 Corrosion Resistance Requirements (for austenitic stainless steel drill collars)

8.3.4.3 The following section shall be added:

8.3.4.3 Pitting Corrosion Resistance

8.3.4.3.1 General

Austenitic stainless steels are subject to pitting and intergranular corrosion in certain environmental conditions. The resistance to pitting corrosion may be specified at the option of the customer to requirements CR1 to CR4, as applicable. These levels relate primarily to the chemical composition. Compositions with higher pitting resistance require more severe test conditions to detect harmful precipitation.

NOTE Test temperature is specified as a minimum; a higher test temperature may always be used at manufacturer's option for tighter quality control.

8.3.4.3.2 Requirements for CR1

CR1 is intended for drilling fluids that are oil-based or water-based with salinity lower than 20,000 mg/l of chloride. Every sample within the forging lot shall be tested according to ASTM A262 Practice A with none showing ditch structure: grains completely surrounded by boundaries with corrosion pits. No further testing of pitting resistance is required.

Material conforming to CR2, CR3, or CR4 may be used where CR1 is specified.

8.3.4.3.3 Requirements for CR2

CR2 is intended for drilling fluids with salinity comparable to sea water.

Resistance to corrosion shall be demonstrated by testing a sample from the forging lot of each non-magnetic drill collar.

A test sample shall be taken from a point 25.4 mm (1.0 in.) or deeper below the outside surface. The sample shall be tested in accordance with ASTM G48 Practice A at 0 °C minimum for 24 hours with mass loss less than 1 mg/cm^2.

Material conforming to CR3 or CR4 may be used where CR 2 is specified.

8.3.4.3.4 Requirements for CR3

CR3 is intended for high-salinity drilling fluids, with salinity exceeding 80,000 mg/l, and may be advantageous for high temperatures.

Resistance to corrosion shall be demonstrated by testing a sample from the forging lot of each non-magnetic drill collar.

A test sample shall be taken from a point 25.4 mm (1.0 in.) or deeper below the outside surface. The sample shall be tested in accordance with ASTM G48 Practice A at 22 °C minimum for 24 hours with mass loss less than 3 mg/cm^2.

Material conforming to CR4 may be used where CR 3 is specified.

8.3.4.3.5 Requirements for CR4

CR4 is intended for high-salinity fluids, exceeding 100,000 mg/l Cl and for temperatures exceeding 125 °C.

Resistance to corrosion shall be demonstrated by testing a sample from the forging lot of each non-magnetic drill collar.

A test sample shall be taken from a point 25.4 mm (1.0 in.) or deeper below the outside surface. The sample shall be tested in accordance with ASTM G48 Practice A at 50 °C minimum for 24 hours with mass loss less than 1 mg/cm^2.

8.3.5 The section shall be changed to the following:

8.3.5 Marking

Non-magnetic drill collars conforming to this standard shall be die-stamped with the following information:

a) the manufacturer's name or identifying mark;

b) outside diameter;

c) bore;

d) non-magnetic identification (non-magnetic drill collar NMDC);

e) connection designation;

f) "API 7-1";

g) CR (CR1 to CR4) if applicable.

NOTE The drill collar number consists of two parts separated by a hyphen; the first part is the connection number in the NC style; the second part, consisting of 2 (or 3) digits, indicates the drill collar outside diameter in units and tenths of inches; drill collars with 209.6 mm, 241.3 mm, and 279.4 mm outside diameters are shown with 6-5/8, 7-5/8, and 8-5/8 REG connections, since there are no NC connections in the recommended range of bending-strength ratios.

The example below illustrates these marking requirements. Location of the markings and the application of additional markings shall be specified by the manufacturer.

EXAMPLE

A 209.6 mm (8-1/4 in.) collar, with 71.4 mm (2-13/16 in.) bore, manufactured by AB Company, and tested to CR3 is stamped:

- AB Co. (or mark) 209.6 71.4 NMDC 6-5/8 REG API 7-1 CR3

OR

- AB Co. (or mark) 8.25 2.81 NMDC 6-5/8 REG API 7-1 CR3

9.1 The section shall be changed to the following:

9.1 General

This section covers the manufacturing specifications of heavy-weight drill pipe (HWDP). HWDP is most used in the bottom-hole assemblies. HWDP should not be confused with thick-wall drill pipe manufactured to meet API 5DP; sometimes also referred to as heavy-weight drill pipe. Similarly, the tool joints in this section are

different from the tool joints in API 5DP. To avoid confusion between the requirements of API 5DP and this standard, the product according to this standard shall be referred to as HWDP. HWDP may be manufactured as a single machined piece (integral HWDP) or as welded assemblies consisting of a tube and tool joints.

9.3 The section shall be changed to the following:

9.3 Outside Diameter Tolerances

The tube and tool joint outside and inside diameter dimensions shall conform to those specified in Table C.26 (Table D.26).

Figure 11 – The figure shall be moved after section 9.3 and the following key shall be added:

Key

D_{EU}	**Weld Upset Diameter**
D	**Tube Diameter**
D_{CU}	**Center Upset Diameter**

9.4 – 9.12: The sections shall be renumbered and changed to the following:

9.4 Bores

All welded and integral HWDP bores shall be gauged with a drift mandrel 3.05 m (10 ft) long minimum. The minimum diameter of the drift mandrel shall not be less than the minimum drift diameter shown in Table C.23 (Table D.23). If product is drilled from each end, the match point shall be located under the center upset or wear pad.

9.5 Connections

9.5.1 Size and Type

HWDP shall be furnished with box up and pin down connections listed in Table C.23 (Table D.23). The connections shall conform to the dimensional and gauging requirements of API 7-2.

NOTE Proprietary connections are not covered by this standard. When proprietary connections are specified in the purchase agreement by the user, they should be specified to conform to the mechanical properties, dimensions, marking, and gauging requirements specified by the manufacturer of the proprietary connections.

9.5.2 Connection Stress Relief Features

Connection stress relief features are optional. When specified in the purchase agreement, stress relief features complying with the dimensions specified in API 7-2 shall be provided.

The surfaces of stress relief features shall be free of stress risers such as tool marks and steel stencil impressions.

The boreback design is the recommended relief feature for box connections. However, the box API relief groove design has been shown to also provide beneficial effects. It may be used as an alternate to the boreback design.

NOTE 1 Laboratory fatigue tests and tests under actual service conditions have demonstrated the beneficial effects of stress relief contours at the pin shoulder and at the base of the box thread. It is recommended that, where fatigue failures at points of high stress are a problem, stress relief features be provided.

NOTE 2 Stress relief features will cause a slight reduction in the tensile strength of the pin and the section modulus of the connection. However, under most conditions this reduction in cross-sectional area is more than offset by the reduction in fatigue failures. If unusually high tensile loads are expected, calculations of the effect should be made.

9.5.3 Cold Working of Thread Roots

When specified in the purchase agreement, cold working of thread roots shall be performed. Method of cold working is optional with the manufacturer, but shall follow the guidelines in TR 7CR

NOTE 1 As with stress relief features, laboratory fatigue tests and tests under actual service conditions have demonstrated the beneficial effects of cold working the thread roots of rotary shouldered connections. It is recommended that, where fatigue failures at points of high stress are a problem, cold working be provided.

NOTE 2 Gauge stand-off will change after cold working of threads and may result in connections that do not fall within the specified gauge standoff if gauged after cold working. This will not affect the interchangeability of connections and will improve connection performance. It is therefore permissible for a connection to be marked as conforming to the requirements of API 7-2 if it meets the standoff requirements before cold working.

If threads are cold worked, they shall be gauged to API 7-2 requirements before cold working and the connection shall also be stamped with a circle enclosing “CW” to indicate cold working after gauging. The mark shall be located on the connection as follows:

a) Pin connection—at the small end of the pin,

b) Box connection—in box counterbore.

9.5.4 Surface Treatment of Threads and Sealing Shoulders for Galling

Atreatment of zinc or manganese or zinc-and-manganese phosphate shall be applied to the threads and the sealing shoulders for all end connections of HWDP.

Application of the treatment shall be after completion of all gauging. The treatment type shall be at the discretion of the manufacturer.

NOTE 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 or zinc-and-manganese phosphate has proven to be beneficial in lessening this problem

9.6 Hard-banding

9.6.1 Requirements

Unless stated otherwise in the purchase agreement, hard-band may be applied on the tool joints (either flush with or raised above the OD) and center upset or wear pad (raised-type only) of HWDP; hard-banding on the

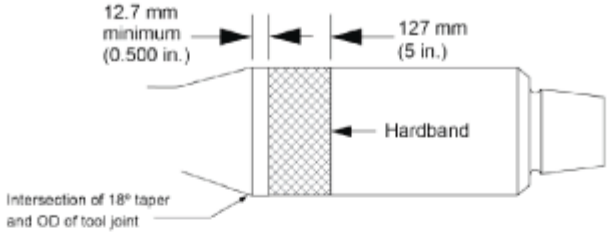
18-degree taper is optional. Figure 13 details the recommended locations and lengths of hard-band. The type of hard-banding shall be specified in the purchase agreement.

If hard-banding is applied to the tool joint, unless otherwise specified, the thickness shall be 2.4 mm +0.8/-0.8 mm (0.094 in. +0.031/-0.031 in.).

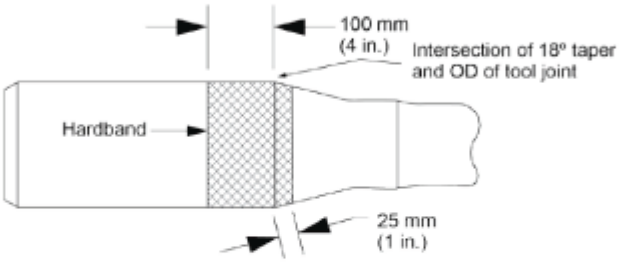
If hard-banding is applied to the center upset or wear pad, unless otherwise specified, the thickness of shall be 2.4 mm +1.6/-0.8 mm (0.094 in. +0.062/-0.031 in.).

9.6.2 Weld Qualification

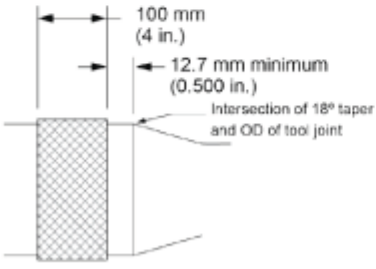
Welding shall be performed using procedures and personnel qualified in accordance with the requirements of ASME *BPVC* Section IX (see section on hard-banding) that specifies the essential and non-essential welding variables. The manufacturer shall maintain procedure qualification records (PQR) and records of welder performance qualifications (WPQ).



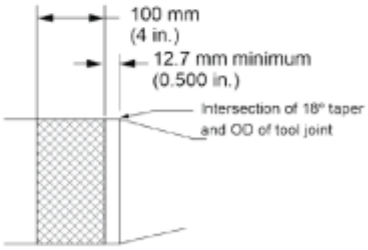
a) Pin tool joint with hardband



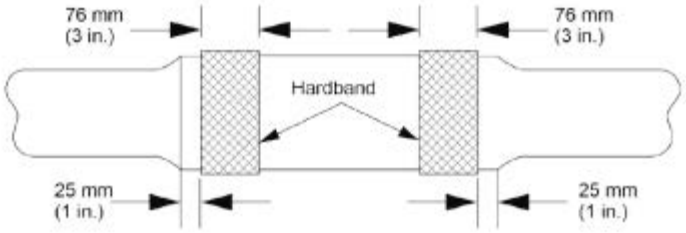
b) Box tool joint with hardband flush with OD and on 18° taper



c) Box tool joint hardband raised on OD but no hardband on 18° taper



d) Box tool joint with hardband flush with OD but no hardband on 18° taper



e) Center upset with hardband

Fi**gure 13—Recommended Hard-banding Locations on HWDP**

9.7 Integral HWDP
9.7.1 Dimensional

The dimensions shall conform to Figure 11 and Table C.26 (D.26)

9.7.2 Material Requirements

Integral HWDP shall be machined from hot-rolled or forged steel bar meeting the requirements for drill collars in this specification. The tensile properties shall be same as for drill collars the same size as the box outside diameter of the HWDP.

9.8 HWDP Tool Joints

9.8.1 Dimensional

The dimensions shall cpnform to the left and right ends of Figure 11 and Table C.26 (D.26) including the Upset D_{EU} There shall be a minimum of 25mm (1 in) of upset length

9.8.2 Material Requirements

9.8.2.1 Material

Tool joints shall be manufactured from forging, forged bar or hot-rolled steel.

9.8.3 Heat Treatment

Heat treatment shall be performed according to a documented procedure. The procedure shall address the permissible number of reheat treatments.

Forgings and hot-rolled steel shall be quenched and tempered for the manufacture of HWDP tool joints.

9.8.4 Heat-treatment Lot

When manufactured from a tool joint forging, a lot shall consist of those pin or box tool joints with the same specified dimensions that are heat treated as part of a continuous operation (or batch), and are of a single heat

of steel, or from different heats that are grouped according to a documented procedure that ensures that the appropriate requirements of this standard are met.

9.8.5 Tensile Requirements

9.8.5.1 General

The tensile properties of the material used to manufacture HWDP tool joints shall comply with the requirements of Table C.25 (Table D.25).

These properties shall be verified by performing a tensile test on one specimen per heat per heat treatment lot.

Tensile properties shall be determined by tests on cylindrical specimens conforming to the requirements of ASTM A370, 0.2 % Offset Method.

Elongation shall be determined in a gauge length of 4x diameter.

9.8.5.2 Tensile Specimen from a Bar

The tensile specimen shall be taken from either end of the bar. The specimen shall be machined so that the center point of the gauge area is located a minimum of 101.6 mm (4 in.) from the end of the bar. The tensile specimen shall be oriented in the longitudinal direction and the longitudinal center of the specimen shall be taken from material at or below the gauge point diameter of the connection.

9.8.5.3 Tensile Specimen from a Tool Joint Forging

The tensile specimen shall be removed from the pin tool joint, as in Figure 12, after final heat treatment. Specimens may be taken from semi-finished products (that is, before threading, machining, or hard-banding operations).

NOTE Conformance with the requirements for tensile properties for the tool-joint box is verified by hardness testing, as in Figure 12.

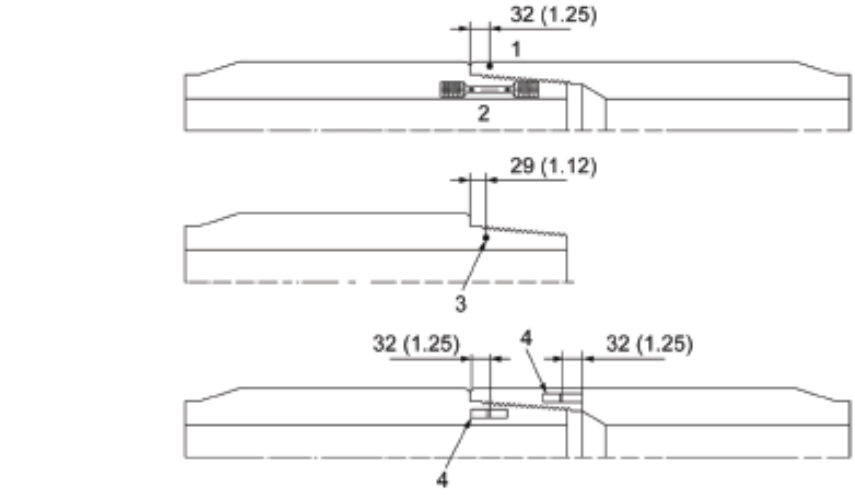
By agreement between the purchaser and manufacturer, tensile tests shall also be undertaken on box tool joints. In such cases, details of testing shall also be agreed.

The test shall be conducted using a 12.7 mm (0.500 in.) diameter round specimen.

If the pin section at the specified location is not sufficient to obtain a tensile specimen of 12.7 mm (0.500 in.) diameter, an 8.9 mm (0.350 in.) or 6.4 mm (0.250 in.) diameter specimen may be used. The largest possible diameter specimen shall be used.

If the pin section at the specified location is not sufficient to obtain a 6.4 mm (0.250 in.) diameter specimen [25 mm (1 in.) gauge length], a hardness test shall be performed on the pin tool joint in accordance with 9.7.5.

Additionally, a tensile specimen shall be removed from the mid-wall location of the thick section of the pin tool joint, after final heat treatment. The largest possible diameter specimen shall be used.



Key
1 box hardness test location
2 pin tensile test specimen
3 pin hardness test location (when required)
4 longitudinal Charpy specimen

Figure 12—Test Specimen Location and Orientation for HWDP Tool Joints

9.7.4.4 Heat Control Tensile Tests for Tool Joint Forgings

When manufactured from a tool joint forging, one tensile test shall be made as a control test from each heat of steel used by the manufacturer to produce tool joint pins under this standard. A record of such tests shall be available to the purchaser.

A heat control test may also be used as a product test for the lot being tested.

9. 8.5.5 Re-test for Bar or Tool Joint Forging

If the initial tensile test fails to conform to the specified requirements, the manufacturer may elect to test two additional specimens from the same piece. If both additional specimens pass, the lot shall be accepted.

9. 8.5.6 Re-test for Tool Joint Forging

If one or both additional specimens fail to conform to the requirements, the manufacturer may elect to test three additional pin tool joints from the same lot. If the specimens from all three pin tool joints conform to the requirements, the lot shall be accepted. If one or more specimens fail to conform to the requirement, the lot shall be rejected.

NOTE: Rejected lots may be reheat treated and tested as new lots.

9.8.6 Hardness Tests for Tool-joint Box Forgings

9.8.6.1 Procedure

Hardness tests shall be performed at room temperature in conformity to ASTM A370 or ASTM E10 for Brinell hardness tests, and ASTM A370 or ASTM E18 for Rockwell C hardness tests.

9.8.6.2 Test Specimen

The specimen shall be removed from the box tool joint forging, as in Figure 12, after final heat treatment.

The specimen may be taken from semi-finished products (i.e. before threading, machining, or hard-banding operations).

If the specified location for the pin tool-joint tensile test is not sufficient to obtain an acceptable tensile test specimen (see 9.8.5.3), a hardness test shall be performed on the pin tool joint as in Figure 12 and in conformance with 9.7.5.

9.8.6.3 Frequency of Testing

The hardness-test frequency for the tool joint shall be performed at the tensile testing frequency or 1 per 100, whichever is more frequent.

When hardness testing is required for pin tool joints due to insufficient material for tensile testing, the hardness testing of the pin tool joint shall be performed at the tensile testing frequency or 1 per 100, whichever is more frequent.

9.8.6.4 Heat Control Hardness Tests

One hardness test shall be made as a control test from each heat of steel used by the manufacturer to produce tool joint boxes; and for tool joint pins if a hardness test is required for conformance in accordance with 9.8.6.2.

A record of such tests shall be available to the purchaser.

A heat control test may also be used as a product test for the lot being tested.

9.8.6.5 Re-tests

Retesting shall be permitted of any tool joint representing a lot that fails to meet the hardness requirements. Two additional tests shall be made, one test approximately three impression diameters from one side of the original test location, and a second test approximately three impression diameters from the opposite side of the original test location.

If both additional tests meet the requirements, the lot shall be accepted.

If one or both additional tests fail to conform to the requirements, the manufacturer may elect to test three additional tool joints from the same lot. If the tests on all three tool joints conform to the requirements, the lot shall be accepted. If one or more tests fail to conform to the requirement, the lot shall be rejected. Rejected lots may be reheat treated and tested as new lots.

9.8.7 Surface Hardness Requirements—Outer Diameter (OD)

9.8.7.1 General

A hardness test shall be performed on each bar, forging, or tube used to manufacture tool joints. The hardness shall conform to the requirements of Table C.25 (Table D.25). The hardness test shall be on the outside diameter of the bar, tool joint forging, or tube.

If the Rockwell C method is used the results shall be converted to Brinell for comparison to the requirement in Table C.25 (Table D.25).

9.8.7.2 Procedure

Hardness testing shall be performed at room temperature in compliance with ASTM A370 or ASTM E10 for Brinell hardness tests, and ASTM A370 or ASTM E18 for Rockwell C hardness tests.

9.8.8 Impact Strength Requirements

9.8.8.1 General

Charpy V-notch impact tests shall be conducted on tool joint specimens after final heat treatment, conforming to the requirements of ASTM A370 or ASTM E23 and shall be conducted at a temperature of 21 °C ± 3 °C (70 °F ± 5 °F). Tests conducted at lower temperatures that meet the requirements stated in 9.8.8.6 are acceptable.

9.8.8.2 Specimens

One set of three per heat per heat treated lot shall be tested.

The impact specimens shall be taken from material at or below the gauge point diameter of the connection. The specimen shall be longitudinally oriented and radially notched.

9.8.8.3 Specimen Size

Full-size specimens of 10 mm × 10 mm (0.394 in. × 0.394 in.) shall be used except where there is insufficient material; in which case the next smaller standard sub-size specimen obtainable shall be used.

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

9.8.8.4 Specimens from Tool Joint Forgings

Specimens may be taken from semi-finished product (that is, before threading, machining, or hard-banding operations), and shall conform to all requirements in 9.8.8.7

9.8.8.5 Heat Control Test

For tool joint forgings, one impact test shall be made as a control on each heat of steel used by the tool joint manufacturer. A record of such tests shall be available to the purchaser.

A heat control test may also be used as a product test for the lot being tested.

9.8.8.6 Acceptance Criteria

The average of the three specimens shall be 54 J (40 ft-lbs) or greater with no single value less than 47 J (35 ft-lbs).

9.8.8.7 Re-test for Bar, Tube, and Tool Joint Forging

If the requirements of 9.8.8.6 are not met and not more than one specimen is below the minimum specimen absorbed-energy requirement, then the manufacturer may elect either to reject the lot or to retest a set of three additional specimens from the same test piece. For all three of these specimens, the absorbed energy shall be equal to or greater than the minimum average absorbed energy requirement, or the lot shall be rejected.

9.8.8.8 Re-test for Tool Joint Forging

If one of the additional specimens fail to conform to the requirements, the manufacturer may elect to test three additional pin tool joints from the same lot. If all the specimens from all three pin tool joints conform to the requirements, the lot shall be accepted. If one or more of the specimens from any of the three pin tool joints fails to conform to the requirement, the lot shall be rejected.

Rejected lots may be re-heat-treated and tested as new lots.

9.8.9 Inspection

Each bar or tool joint forging used for HWDP tool joints shall be examined for both surface and internal defects in accordance with Section 12.

9.9 HWDP Tube

9.9.1 Dimensional Requirements

The tube section shall conform to the center section of figure 11 and Table C.24 (D.24). It shall include a minimum of 25 mm ((1 in) of the upset diameter D_{EU} at each end to allow for the weld to be located there.

9.9.2 Material Requirements

9.9.2.1 Mechanical Properties

Tubes shall be manufactured from normalized, normalized, and tempered, or quenched and tempered seamless alloy steel meeting the following mechanical property requirements.

a) Minimum tensile strength—655 MPa (95,000 psi)

b) Minimum yield strength—379 MPa (55,000 psi)

c) Minimum elongation—18 %

9.9.3 Inspection

Tubes shall be examined, which may occur prior to or after machining, for both surface and internal effects in accordance with Section 12.

9.9.4 Disposition of Defects

All defects discovered in drifting or inspection shall be removed, within allowable tolerances.

9.9.5 External Surface Defects

The external surface of the center upset (or wear pad) shall be hot-rolled mill finish or machined. If the surface is mill-finished, imperfections may be removed by grinding. If imperfections are removed, the depth of the removal shall comply with Table C.24 (Table D.24) and grinds shall be contoured with the surface of the upset.

External surface imperfections in machined areas of the tube OD may be blended to remove them if the depth is less than 1.59 mm (1/16 in.).

Diameter tolerances shall not be applied to localized areas of imperfection removal.

9.10 HWDP Assembly

9.10.1 General

HWDP when welded shall consist of a box tool joint, a tube section, and a pin tool joint, welded together.

The requirements for HWDP tool joints can be found in 9.8. Tool joints conforming to API 5DP are also acceptable.

The requirements for the tube section can be found in 9.9

9.10.2 Dimensional

The welded assembly shall conform to Figure 11 and Table C.25 (D.25)

9.10.3 Tool Joint Alignment

The maximum angular misalignment between the longitudinal axis of the tube and the longitudinal axis of the tool joint shall be 10 mm/m (0.010 in./in.) for Size 4 and smaller, and 8 mm/m (0.008 in./in.) for larger sizes. The maximum parallel misalignment between the longitudinal axis of the tube and the longitudinal axis of the tool joint shall be 3.2 mm (0.125 in.) total indicator reading. The misalignment measurements shall be taken at the approximate longitudinal mid-point of the tool joint outer diameter (also known as tong length).

9.10.4 Welding

The design of the tool joint to tube weld shall be such that the weld is located in upset section denoted by D_{EU} and is not located in the radius between the tube and tool joint taper. The design of the weld shall ensure that the strength of the weld (cross sectional area of the weld times the minimum yield strength of the weld) exceeds the strength of the tube section (minimum cross sectional area of the tube times the minimum yield strength of the tube). The welding shall be performed in accordance with a written welding procedure specification (WPS) that specifies the essential and non-essential welding variables. The welding procedure specification shall include a post-weld heat treatment to ensure that the hardness is less than 37 HRC and that the minimum weld yield strength is satisfied. The welding procedure shall be qualified by destructive testing to demonstrate that the minimum yield strength and hardness requirements of the weld are satisfied. The welding machine operators shall be qualified by documenting completion of a weld that satisfies these requirements. The manufacturer shall maintain procedure qualification records (PQR) and records of welder performance qualifications (WPQ).

9.10.5 Inspection

Each weld zone shall be hardness tested in the heat affected zone to demonstrate the surface hardness of the weld zone is less than 37 HRC. The hardness testing method is optional with the manufacturer.

9.11 Traceability

The HWDP manufacturer shall establish and follow procedures for maintaining heat identity. The methods of maintaining identity shall beat the option of the manufacturer. These procedures shall provide means for tracing the tool joints and pipe body to the relevant heat, chemical analysis report, and specified mechanical tests results. Lot identity shall be maintained until all required lot tests are performed and conformance with specified requirements has been shown.

9.12 Marking

HWDP conforming to this standard shall be steel stencil-stamped on the taper of the pin end or on the tool joint OD or center upset or wear pad, with the manufacturer’s name or mark, “API 7-1”, and traceability identification.

If a slot is used on the center upset or wear pad, the depth shall not be below the tube OD. Stamping shall not be done in highly stressed areas such as the radius between the tube and tool joint taper, weld line or the tube machined OD.

a) the manufacturer's name or identifying mark;

b) industry mark; (only for product completely conforming to this specification)

c) tube diameter;

d) connection designation;

e) "API 7-1"

f) Traceability identification

The example below illustrates these marking requirements.

EXAMPLE

AB Co. (or Mark)

(Industry Mark)

4-1/2

NC46

API 7-1

(traceability ID)

10: The sections shall be changed to the following:

10 Drill Bits

10.1 General Requirements

10.1.1 Design Requirements

The manufacturer shall maintain a design file for each size and type of bit. This shall include as a minimum:

a) written material specifications for all metallic materials,

b) dimensional requirements,

c) definition of material and positions of cutting elements,

d) welding procedures, and

e) bearing design.

10.1.2 Diameter

10.1.2.1 General

All drill bits shall have the outer diameter inspected using the dimensional guidelines given in 10.1.2.2 and 10.1.2.3. The use of the gauges themselves is not required, except in the case of dispute. , “WT”

10.1.2.2 Gauge Specification

“Go” and “no-go” gauges shall be fabricated as shown in Figure 14a and as described below.

a) “Go” and “no-go” gauges shall be a ring fabricated from steel with minimum height 19 mm (3/4 in.) at the ID “WT”, and 19 mm (0.75 in.) minimum radial cross section, “GT”. In order to reduce the mass, the outer section may be reduced as shown by dimensions “GT1” and “WT1”. The gauges shall be marked as shown with the nominal bit diameter and either “GO” or “NOGO”

b) The “go” gauge ID, D_1, shall equal the maximum bit size (nominal bit size plus maximum positive tolerance) plus 0.05 mm (0.002 in.) clearance, with a tolerance of $^{+0.08}/_{0}$ mm ($^{+0.003}/_{0}$ in.).

c) The “no-go” gauge ID, D_2, shall equal the minimum bit size (nominal size less maximum negative tolerance) minus 0.05 mm (0.002 in.) interference, with a tolerance of $^{0}/_{-0.08}$ mm ($^{0}/_{-0.003}$ in.).

1

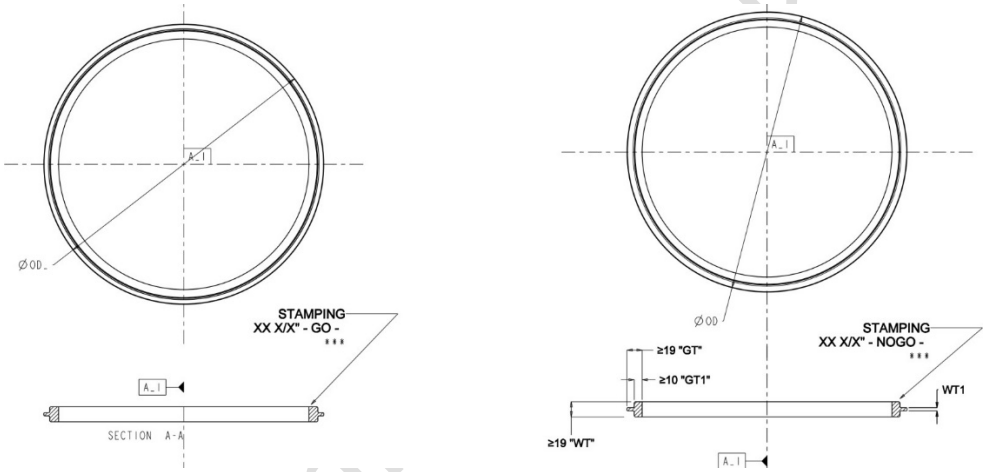


Figure 14a—Bit Diameter Gauge

Key

- WT Gauge Height at Inside Diameter
- WT1 Thickness of Optional reinforcing rib 10 mm 0.4 in) minimum
- GT Total Gauge Thickness
- GT1 Thickness of full gauge section 10 mm (0.4 in) minimum

10.1.2.3 Gauging Practice

The “go” and “no-go” gauges shall be used as follows:

a) if acceptable, the product bit shall pass through the “go” gauge (product not too large),

b) if acceptable, the product bit shall not pass through the “no-go” gauge (product not too small), and

c) for accurate measurement, the temperature of both the “go” and “no-go” gauges shall be within 11 °C (20 °F) of the temperature of the bit.

10.1.3 Connections

Bits shall be furnished in the size and style of the pin connection shown in Table C.24 (Table D.24). All connection threads shall be right-hand.

10.1.4 Marking

Bits shall be die-stamped in some location other than the make-up shoulder with the following information:

a) manufacturer's name or identification mark,

b) the bit size (in whole mm or in., by either three-place decimal or fractional),

c) "API 7-1";

d) Industry Mark

e) the size and style of connection (abbreviations are acceptable).

EXAMPLE A 200 mm (7-$^{7}/_{8}$ in.) bit with 4-$^{1}/_{2}$ REG rotary shouldered connection would be stamped as follows:

AB Co. (or mark) 200 API 7-1 4-$^{1}/_{2}$ REG

OR

AB Co. (or mark) 7.875 API 7-1 4-$^{1}/_{2}$ REG

OR

AB Co. (or mark) 7-$^{7}/_{8}$ API 7-1 4.5R

10.1.5 Operational Requirements

The manufacturer shall specify the following:

a) the minimum and maximum acceptable make-up torque; the maximum make-up torque shall not be less than the value shown in Table C.27 (Table D.27) and shall be justified by engineering calculations,

b) the maximum acceptable weight on bit (WOB) justified by engineering calculations or by validation testing,

c) the value for maximum acceptable overpull justified by engineering calculations or by validation testing, and

d) hydraulic performance data, including pressure drop as a function of nozzle configuration and mud weight; these data shall be justified by a combination of validation testing and engineering calculations.

10.2 Roller Cone Bits

The gauge diameter of the cutting edge of roller cone bits shall conform to the OD tolerances specified in Table C.26 (Table D.26).

10.3 Fixed Cutter Bits

10.3.1 Diamond Bit Tolerances

Fixed cutter bits shall be subject to the OD tolerances shown in Table C.29 (Table D.29).

10.3.2 Diamond Drilling Bit and PDC Bit Connections

Fixed cutter bits shall be furnished with the size and style pin connection shown in Table C.27 (Table D.27). All connection threads shall be right-hand.

Because of their proprietary nature, the connections on diamond core bits are not shown.

10.3.3 Breaker Slot

Fixed cutter bits shall be furnished with a breaker slot to apply make-up and break-out torque.

A typical geometry is shown in Figure 14b. The manufacturer shall make available a corresponding breaker tool.

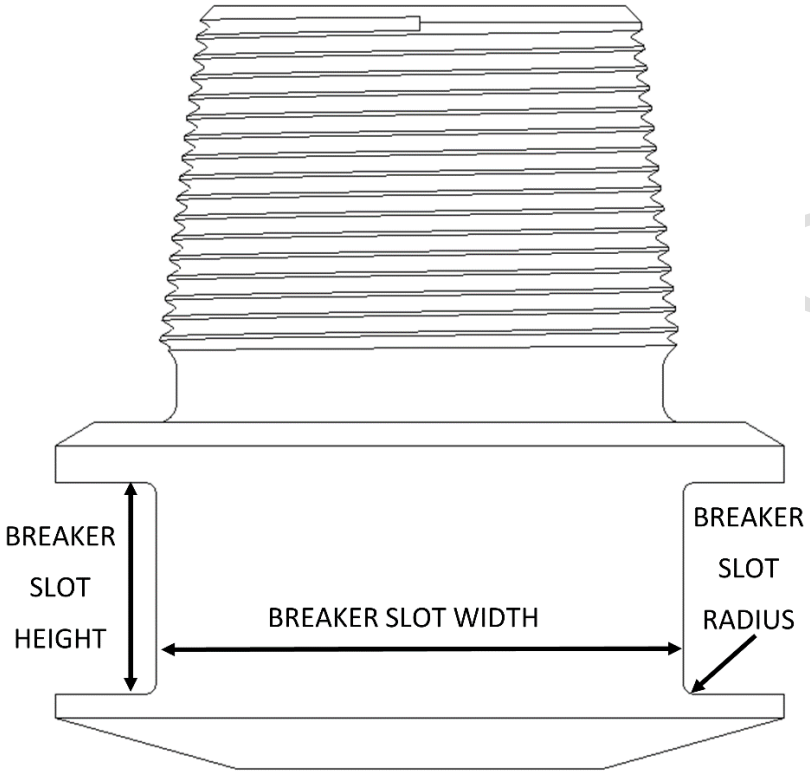


Figure 14b—Typical Breaker Slot

10.3.4 Materials

All metallic materials of the connection portion shall conform to a written material specification. The steel shall not exceed sulfur and phosphorus contents of 0.04 %.

The material of the connection portion of fixed cutter bits shall conform to Table C. 28 (Table D.28).

10.3.5 Welds

10.3.5.1 General

For all welds used to join a connection to a bit body, the manufacturer shall develop, qualify, and use a welding procedure, including any postweld heat treatment [WPS and procedure qualification record (PQR)], in accordance with ASME BPVC Section IX. The procedure shall identify the essential variables and non-essential variables and address the permissible number of reheat treatments.

The PQR shall include, as a minimum, the data of the specific variables (both essential and non-essential) and the results of all mechanical tests to verify the properties in 10.3.5.2 carried out on specimens taken from the test weld.

The manufacturer shall qualify the welding machines and welding operators to a specific welding operator performance qualification (WPQ) for each WPS utilized by the operators.

10.3.5.2 Weld Qualification

The WPQ shall include all properties required by AME BPVC Section IX for the type of weld specified.

10.4 Fixed Cutter Bits—Supplementary Requirements

10.4.1 General

This section describes supplementary requirements for fixed cutter bits that may be specified by the purchaser or agreed between purchaser and manufacturer. These requirements apply only when stated on the purchase agreement. These supplementary requirements are only applicable to polycrystalline diamond compact bits and diamond drilling bits.
NOTE These supplementary requirements are designed to mitigate fatigue crack failures that occurred in the pin connections of small diameter (≤ 6-3/4 in. OD) fixed cutter bits; even though these requirements may be specified for any diameter bit size, they may not be as beneficial on larger diameter (> 6-3/4 in. OD) bits.

10.4.2 Supplementary Requirement 1 (SR1)—Gall-resistant Treatment of Threads and Sealing Shoulders

10.4.2.1 SR1 General Information

A gall-resistant treatment of zinc phosphate or manganese or zinc-and-manganese phosphate shall be applied to the threads and sealing shoulders of the bit's pin connection, or box connection if supplied with a box connection. Application of the treatment shall be after completion of all gauging. The treatment type shall be at the discretion of the manufacturer.

10.4.2.2 SR1 Marking

Bits treated to the supplementary requirements of SR1 shall be marked with "SR1" in addition to the marking requirements specified in 10.1.4.

10.4.3 Supplementary Requirement 2 (SR2)—Cold Rolling of Thread Roots

10.4.3.1 SR2 General Information

The thread roots shall be cold rolled. As with stress relief features, laboratory fatigue tests and tests under actual service conditions have demonstrated the beneficial effects of cold rolling the thread roots of rotary shouldered connections. Application of the cold rolling shall be after completion of connection gauging as in accordance with API 7-2.
Gauge standoff will change after cold rolling of the threads and may result in connections that do not fall within the specified gauge standoff if gauged after cold rolling. This will not affect the interchangeability of connections and will improve connection performance. It is therefore permissible for a connection to be marked as complying with the requirements of API 7-2 if it meets the standoff requirements before cold rolling. In such event, the connection shall be stamped with a circle enclosing "CW" to indicate cold rolling after gauging. The mark shall be located on the connection as follows:
a) Pin connection – at the small end of the pin,

b) Box connection – in the counterbore.

10.4.3.2 SR2 Marking

Bits treated to the supplementary requirements of SR2 shall be marked with “SR2” in addition to the marking requirements specified in 10.1.4.

10.4.4 Supplementary Requirement 3 (SR3)—Stress-relief Features

10.4.4.1 SR3 General Information

Stress-relief features shall be added to bit connections 4-1/2 REG and larger. The surfaces of stress-relief features shall be free of stress risers such as tool marks and steel stencil impressions. The stress-relief features shall conform to the dimensions specified in API 7-2.
Laboratory fatigue tests and tests under actual service conditions have demonstrated the beneficial effects of stress-relief contours at the pin shoulder and at the base of the box thread. Stress-relief features are of two basic designs: a groove on the pin and a boreback contour for boxes, or a groove on both the pins and boxes. The boreback design is the recommended relief feature for box connections. However, the box relief groove has also been shown to provide beneficial effects. It may be used as an alternative to the boreback design.
Stress-relief features cause a slight reduction in the tensile strength of the pin and the section modulus of the connection. However, under most conditions the reduction in cross-sectional area is more than offset by the reduction in fatigue failures. If unusually high tensile loads are expected, calculations of the effect should be made.

10.4.4.2 SR3 Marking

Bits treated to the supplementary requirements of SR3 shall be marked with “SR3” in addition to the marking requirements specified in 10.1.4.

10.4.5 Supplementary Requirement 4 (SR4)—Non-destructive Examination

10.4.5.1 SR4 General Information

All bit connections, after threading and any heat treating, shall be inspected via bi-directional wet fluorescent residual magnetic particle method for longitudinal and transverse imperfections/cracks both on the inside and outside surfaces in accordance with ASTM E3024709. Internal surfaces of connections with ID bores 50.8 mm (2 in.) in diameter or smaller are exempt from this requirement. Inspection shall include the stress relief features. Outside inspection shall include the entire connection thread area from pin end or box end shoulder, up to and including the bit shank area. Evaluate all crack-like indications to verify that they are cracks. All bits found to have cracks shall be rejected.

10.4.5.2 SR4 Marking

Bits treated to the supplementary requirements of SR4 shall be marked with “SR4” in addition to the marking requirements specified in 10.1.4.

10.4.6 Supplementary Requirement 5 (SR5)—Make-up Torque

All bit connections, after threading and any heat treating, shall be inspected via bi-directional wet fluorescent residual magnetic particle method for longitudinal and transverse imperfections/cracks both on the inside and outside surfaces in accordance with ASTM E3024709. Internal surfaces of connections with ID bores 50.8 mm (2 in.) in diameter or smaller are exempt from this requirement. Inspection shall include the stress relief features. Outside inspection shall include the entire connection thread area from pin end or box end shoulder, up to and including

the bit shank area. Evaluate all crack-like indications to verify that they are cracks. All bits found to have cracks shall be rejected.

Table C.27: The Table title and content shall be changed to the following:

Table C.27— Bit Connections

Bit Size Range OD	Connection	Bit Bevel Diameter ±0.4	Minimum MUT Capability FC	Max ID, FC	Minimum MUT Capability RC
44.4 to <57.2	1 REG	38.1	1355	19.1	434
57.2 to <88.8	1 1/2 REG	50.0	2710	25.4	1030
88.8 to <117.5	2 3/8 REG	78.2	4065	25.4	4065
	NC23 [a]	76.2	4743	38.1	
117.5 to <130.2	2 7/8 REG	92.5	6233	31.7	6098
	NC26 [a]	101.6	7453	38.1	
130.2 to <190.5	3 1/2 REG	105.2	10,298	38.1	9485
	NC35 [a]	110.3	14,634	50.8	
190.5 to <238.9	4 1/2 REG	136.1	23,035	57.1	16,260
238.9 to <389.9	6 5/8 REG	187.7	51,490	82.6	37,940
389.9 to <471.5	6 5/8 REG	187.7	51,490	82.6	37,940
	7 5/8 REG	215.9	81,300	95.3	
471.5 and larger	7 5/8 REG	215.9	81,300	95.3	46,070
	8 5/8 REG	243.3	135,500	95.3	

[a] Fixed cutter only.

Table C.28: The Table title and content shall be changed to the following:

Table C.28—Fixed Cutter Bit Connection Materials

Property	Values *
Yield strength	690 MPa minimum
Tensile strength	930 MPa minimum
Elongation	10 % minimum
Charpy impact toughness	54 J minimum average of three samples
Hardness	285 HBW minimum
* Values determined at ambient temperature.	

Table D.27: The Table title and content shall be changed to the following:

Table D.27—Bit Connections

Size of Bit OD	Connection	Bit Bevel Diameter $\pm 1/64$	Minimum MUT Capability	Max ID, FC	Minimum MUT Capability
1.75 to <2 1/4	1 REG	1 1/2	1000	3/4	(320)
2 1/4 to <3 1/2	1 1/2 REG	1 31/32	2000	1	(760)
3 1/2 to <4 1/2	2 3/8 REG	3 5/64	3000	1	3000
	NC23 [a]	3	3500	1 1/2	
4 5/8 to <5 1/8	2 7/8 REG	3 41/64	4600	1 1/4	4500
	NC26 [a]	4	5500	1 1/2	
5 1/8 to <7 1/2	3 1/2 REG	4 9/64	7600	1 1/2	7000
	NC35 [a]	4 11/32	10,800	2	
7 1/2 to <9 1/2	4 1/2 REG	5 23/64	17,000	2 1/4	12,000
9 1/2 to <14 1/2	6 5/8 REG	7 25/64	38,000	3 1/4	28,000
14 1/2 to <18 5/8	6 5/8 REG	7 25/64	38,000	3 1/4	28,000
	7 5/8 REG	8 1/2	60,000	3 3/4	34,000
18 5/8 and larger	7 5/8 REG	8 1/2	60,000	3 3/4	34,000
	8 5/8 REG	9 37/64	100,000	3 3/4	42,000

[a] Fixed cutter only.

Table D.28: The Table title and content shall be changed to the following:

Table D.28—Fixed Cutter Bit Connection Materials

Property	Values *
Yield strength	100 ksi minimum
Tensile strength	135 ksi minimum
Elongation	10 % minimum
Charpy impact toughness	40 ft-lb minimum average of three samples
Hardness	285 HBW minimum
* Values determined at ambient temperature.	