

Rotary Drill Stem Elements

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Rotary Drill Stem Elements

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](#)).

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Recommended Practice 7G, *Drill Stem Design and Operating Limits*

API Specification 7-2, *Threading and Gauging for Rotary Shouldered Connections*

ASME Boiler and Pressure Vessel Code (BPVC), Section IX, *Welding, Brazing, and Fusing Qualifications*

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Non-Destructive Testing*

ASTM A262, *Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A434, *Standard Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered*

ASTM E10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

ASTM E23, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

ASTM E213, *Standard Practice for Ultrasonic Examination of Metal Pipe and Tubing*

ASTM E309, *Standard Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation*

ASTM E1209, *Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Water-Washable Process*

ASTM E1219, *Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process*

ASTM E1220, *Standard Test Method for Visible Penetrant Examination Using the Solvent-Removable Process*

ASTM E1418, *Standard Test Method for Visible Penetrant Examination Using the Water-Washable Process*

ASTM E3024, *Standard Practice for Magnetic Particle Testing for General Industry*

ISO 6892, *Metallic materials — Tensile testing*

ISO 10893-5, *Non-destructive testing of steel tubes — Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

ISO 11484, *Steel tubes for pressure purposes — Qualification and certification of non-destructive (NDT) personnel*

NACE MR0175/ISO 15156, *Petroleum and natural gas industries—Materials for use in H₂S-containing environments in oil and gas production*

SAE AMS H-6875, *Heat Treatment of Steel Raw Materials*

3 Terms, Definitions, Abbreviations, and Symbols

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1

A-scan display

The ultrasonic instrument display in which the received signal is displayed as a vertical height or “pip” from the horizontal-sweep time trace, while the horizontal distance between two signals represents the material distance for time of travel between the two conditions causing the signals.

3.1.2

amplitude

The vertical height of the A-scan received signal, measured from base to peak or peak to peak.

3.1.3

back reflection

The signal received from the back surface of a surface test object.

3.1.4

bending strength ratio

BSR

The ratio of the section modulus of a rotary shouldered box at the point in the box where the pin ends, when made up, to the section modulus of the rotary shouldered pin at the last engaged thread.

3.1.5

bevel diameter

The outer diameter of the sealing shoulder of a rotary shouldered connection.

3.1.6

bit sub

A sub, usually with two box connections, that is used to connect the bit to the drill stem.

3.1.7

blade

An enlarged region of stabilizer intended to contact the walls of the borehole.

3.1.8

box connection

A threaded connection on oilfield country tubular goods (OCTG) that has internal (female) threads.

3.1.9

calibration system

The documented system of gauge calibration and control.

3.1.10

cold working

The plastic deformation of the thread roots of a rotary shouldered connection, of radii, and of cylindrical sections at a temperature low enough to ensure or cause permanent strain of the metal.

3.1.11

core

The continuous member of a welded-blade stabilizer.

3.1.12

crown length

The axial extent of full-blade diameter except when blades have water-melon profile.

3.1.13

decarburization

The loss of carbon from the surface of a ferrous alloy as a result of heating in a medium that reacts with the carbon at the surface.

3.1.14

defect

An imperfection of sufficient magnitude to warrant rejection of the product based on criteria defined in this standard.

3.1.15

depth prove-up

The act of grinding a narrow notch across a surface-breaking indication until the bottom of the indication is located and then measuring the depth of the indication with a depth gauge for comparison to acceptance criteria.

3.1.16

drift

A gauge used to check minimum internal diameter of drill stem components.

3.1.17

drill collar

Thick-walled pipe used to provide stiffness and concentration of mass at or near the bit.

3.1.18

drill pipe

A length of tube, usually steel, to which special threaded connections called tool joints are attached.

3.1.19

forge (verb)

To make or shape a metal by heating and then hammering it into desired shape by use of compressive force.

NOTE Dies may be used to attain the final desired shape.

3.1.20

forging (noun)

The "product" shaped metal part formed by the forging method.

3.1.21**full-depth thread**

The thread in which the thread root lies on the minor cone of an external thread or on the major cone of an internal thread.

3.1.22**gas-tight**

A capable of holding gas without leaking under the specified pressure for the specified length of time.

3.1.23**gauge point**

The plane perpendicular to the thread axis in API rotary shouldered connections.

NOTE The gauge point is located 15.9 mm (0.625 in.) from the shoulder of the product pin.

3.1.24**gouge**

An elongated groove or cavity caused by mechanical removal of metal.

3.1.25**H₂S-trim**

All components, except external valve body, meeting the H₂S service requirements of NACE MR0175/ISO 15156.

3.1.26**hard-banding****(hard-facing)**

Metalworking process where harder material is applied to a base metal to reduce external wear.

3.1.27**hardness number**

The result from a single hardness impression.

3.1.28**heat****(heat of steel)**

The metal produced by a single cycle of a batch-melting process.

3.1.29**heat analysis**

A chemical analysis representative of a heat as reported by the metal producer.

3.1.30**imperfection**

A discontinuity in the product wall or on the product surface that can be detected by an NDE method included in this standard.

3.1.31**indication**

Evidence of a discontinuity that requires interpretation to determine its significance.

3.1.32**inspection**

The process of measuring, examining, testing, gauging, or otherwise comparing the product with the applicable requirements.

3.1.33

integral-blade stabilizer

A stabilizer manufactured from single piece of material.

3.1.34

kelly

A square or hexagonally shaped steel pipe connecting the swivel to the drill pipe that moves through the rotary table and transmits torque to the drill stem.

3.1.35

kelly saver sub

A short rotary sub that is made up onto the bottom of the kelly to protect the pin end of the kelly from wear during make-up and break-out operations.

3.1.36

label

A dimensionless designation for the size and style of a rotary shouldered connection.

3.1.37

length of box thread

LBT

The length of threads in the box measured from the make-up shoulder to the intersection of the non-pressure flank and crest of the last thread with full thread depth.

3.1.38

linear imperfection

An imperfection that includes, but is not limited to seams, laps, cracks, plug scores, cuts, gouges, and elephant hide (see API 5T1).

3.1.39

lot

A definite quantity of product manufactured under conditions that are considered uniform for the attribute being inspected.

3.1.40

lot size

The number of units in a lot.

3.1.41

lower kelly valve (kelly cock)

A full-opening style valve installed immediately below the kelly, with outside diameter equal to the tool joint outside diameter, that can be closed to remove the kelly under pressure and can be stripped in the hole for snubbing operations.

3.1.42

low stress steel stamps

Steel stamps that do not contain any sharp protrusions on the marking face.

3.1.43

make-up shoulder

The sealing shoulder on a rotary shouldered connection.

3.1.44

mean hardness number

The result of averaging the hardness numbers for the single specimen or location being evaluated.

3.1.45**neck**

The region at upper and lower end of stabilizer that contains connections.

3.1.46**non-essential variable**

A variable parameter in which a change may be made in the WPS without re-qualification.

3.1.47**nonlinear imperfection**

An imperfection that includes, but is not limited to, pits (see API 5T1).

3.1.48**non-pressure flank [box]**

The thread flank farthest from the make-up shoulder where no axial load is induced from make-up of the connection or from tensile load on the drill stem member.

3.1.49**non-pressure flank [pin]**

The thread flank closest to the make-up shoulder where no axial load is induced from make-up of the connection or from tensile load on the drill stem member.

3.1.50**out-of-roundness**

The difference between the maximum and minimum diameters of the bar or tube, measured in the same cross-section.

NOTE Does not include the surface finish tolerances outlined in [8.1.4](#).

3.1.51**pin end**

The external (male) threads of a threaded connection.

3.1.52**procedure qualification record****PQR**

Written documentation stating an assessment that a specific WPS produces welds in accordance with the requirements of this standard.

3.1.53**process of quenching**

The hardening of a ferrous alloy by austenitizing and then cooling rapidly enough so that some or all of the austenite transforms to martensite.

3.1.54**process of tempering**

Reheating a quench hardened or normalized ferrous alloy to a temperature below the transformation range and then cooling to soften and remove stress.

3.1.55**purchaser**

The party responsible for both the definition of requirements for a product order and for payment for that order.

3.1.56**quench crack**

crack in steel resulting from stresses produced during the transformation from austenite to martensite.

NOTE This transformation is accompanied by an increase in volume.

3.1.57

reference dimension

The dimension that is a result of two or more other dimensions.

3.1.58

rotary shouldered connection

A connection used on drill stem elements which has tapered threads and sealing shoulders.

3.1.59

sample

One or more units of product selected from a lot to represent that lot.

3.1.60

seamless pipe

The wrought steel tubular product made without a weld seam.

NOTE It is manufactured by hot working and, if necessary, by subsequently cold-working or heat-treating, or a combination of these operations to produce the desired shape, dimensions, and properties.

3.1.61

stabilizer blade diameter

The diameter at largest cross section.

3.1.62

stress-relief features

The modification performed on rotary shouldered connections by removing the unengaged threads on the pin or box to make the joint more flexible and to reduce the likelihood of fatigue cracking in highly stressed areas.

3.1.63

sub

The short drill stem members with different rotary shouldered connections at each end for the purposes of joining unlike members of the drill stem.

3.1.64

swivel

A device at the top of the drill stem that permits simultaneous circulation and rotation.

3.1.65

tensile strength

The maximum tensile stress that a material is capable of sustaining that is calculated from the maximum load during a tensile test carried to rupture and the original cross-sectional area of the specimen.

3.1.66

tensile test

The mechanical test used to determine the mechanical response of material under tension load.

3.1.67

test pressure

The pressure above working pressure used to demonstrate structural integrity of a pressure vessel.

3.1.68

thread form

The thread profile in an axial plane for a length of one pitch.

3.1.69**Tolerance**

The amount of variation permitted.

3.1.70**tool joint**

A heavy coupling element for drill pipe having coarse, tapered threads, and sealing shoulders.

3.1.71**upper kelly valve
(kelly cock)**

The valve immediately above the kelly that can be closed to confine pressures inside the drill stem.

3.1.72**welded-blade stabilizer**

A stabilizer manufactured by welding blades to a core.

3.1.73**working pressure**

The pressure to which a particular piece of equipment is subjected during normal operation.

3.1.74**working temperature**

The temperature to which a particular piece of equipment is subjected during normal operation.

3.1.75**wrap angle**

The total angular extent of full blade diameter summed across all blades.

3.2 Abbreviations and Symbols

For the purposes of this document, the following abbreviations and symbols apply.

A_m	cross-sectional area of the tensile specimen, expressed in square millimeters (square inches)
AMMT	American macaroni tubing style of thread design
AMT	alternate abbreviation for AMMT
BSR	bending strength ratio
C	standard Charpy impact energy, expressed in foot-pounds
C_m	standard Charpy impact energy, expressed in Joules
D	outside diameter
D_{PB}	diameter baffle plate recess
D_C	distance across corners, forged kellys
D_{CC}	distance across corners, machined kellys
D_F	bevel diameter (pin and box)
D_{FL}	distance across flats on kellys
D_{FR}	diameter float valve recess
D_L	outside diameter, lift shoulder

D_{LR}	outside diameter, kelly lower upset
D_R	outside diameter, reduced section
D_S	diameter slip groove
D_U	outside diameter, upper kelly upper upset
d	inside diameter
d_B	decibel
d_b	inside bevel
e	minimum extension in a gauge length of 50.8 mm (2.0 in.)
e_m	minimum elongation
F_h	API full-hole style of thread design
G	gauge length
HBW	Brinell hardness
L	overall length
L_D	length kelly drive section
L_{FV}	length float valve assembly
L_G	minimum length kelly sleeve gauge
LH	left hand
L_L	lower upset length, kellys
L_R	depth of float valve recess
L_U	upper upset length, kellys
I_S	slip recess groove depth
MT	magnetic particle testing
M.T.	macaroni tubing style of thread design
N	fraction or number with a fraction
NC	API number style of thread design
NPC	non-preferred connections
PT	liquid penetrant testing
R	radius
R_c	corner radius, forged kelly
R_{cc}	corner radius, machined kelly
REG	API regular style of thread design
RH	right hand
R_H	maximum fillet radius, hexagonal kelly sleeve gauge
R_S	maximum fillet radius, square kelly sleeve gauge
RSC	rotary shouldered connection
THD	thread

T_s	tensile strength
t	minimum wall thickness

4 Conformance

4.1 General Illustration of Typical Drill Stem Elements

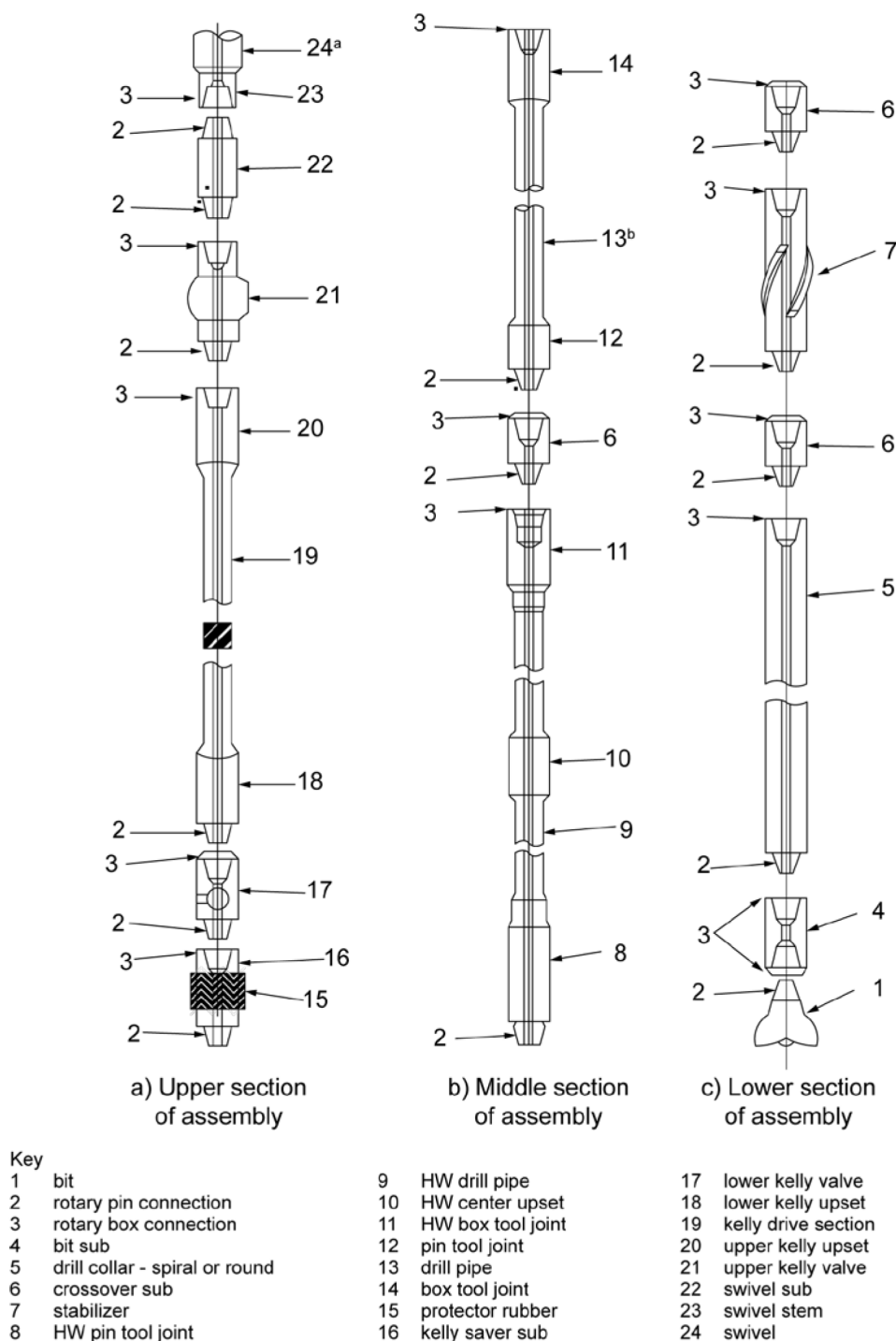


Figure 1—Typical Drill-stem Assembly

4.2 References to Annexes

For additional information regarding inspections by the purchaser, as referred, see [Annex A](#).

For additional requirements or information concerning the manufacturing of rotary drill stem elements, as referenced, see the following.

- material requirements, see [Annex B](#) (normative);
- product tables in SI units, see [Annex C](#) (normative);
- product tables in USC units, see [Annex D](#) (normative);
- conversion procedures for USC to SI units, see [Annex E](#) (informative).

4.3 Dual Citing of References

In the interest of worldwide application of this technical report, the API Subcommittee on Tubular Goods (SC5) has decided, after detailed technical analysis, that certain documents listed in [Section 2](#) and prepared by API SC5 or other technical committees are interchangeable in the context of the relevant requirement with the relevant document prepared by the International Organization for Standardization (ISO) or the American Society for Testing and Materials (ASTM). These latter documents are cited in the running text following the API reference and preceded by “or” for example, “API XXXX or ISO YYYY” or “ISO YYYY or ASTM ZZZZ”. Application of an alternative document cited in this manner may lead to technical results different from the use of the preceding API reference. However, both results are acceptable, and these documents are thus considered interchangeable in practice.

4.4 Units of Measurement

In this standard, data are expressed in both the International System (SI) of units and the United States Customary (USC) system of units. For a specific order item, it is intended that only one system of units be used without combining data expressed in the other system.

Products manufactured to specifications expressed in either of these unit systems shall be accepted as equivalent and totally interchangeable. Consequently, compliance with the requirements of this standard as expressed in one system provides compliance with requirements expressed in the other system.

In the text, data in SI units are followed by data in USC units in brackets.

4.5 Marking of Threaded-only Rotary Shouldered Connections (RSC)

When specified, for threaded-only RSCs used on products in accordance with this standard, the following shall be identified by stamping or stenciling the product adjacent to the connection with the following:

- a) threader's name or mark (optional),
- b) “API 7-2”,
- c) THD,
- d) date of threading, and
- e) size and style of connection.

EXAMPLE—An NC46 connection would be marked: AB Co. (or mark), API 7-2, THD Mo [xx]-Yr [yy], NC46.

NOTE The connection marking may be applied to products, which are not covered by API standards if the threading and gauging stipulations in API 7-2 are met.

5 Upper and Lower Kelly Valves

5.1 General

This standard specifies the minimum design, material, inspection, and testing requirements for upper and lower kelly valves. This standard also applies to drill stem safety valves used with overhead drilling systems. It applies to valves of all sizes and shall be furnished with rated working pressures of 34.5 MPa, 68.9 MPa or 103.5 MPa (5000 psi, 10,000 psi or 15,000 psi) used in normal service conditions (H₂S service conditions are addressed as a supplementary requirement, see [5.8](#)). Rated working temperatures are –20 °C (–4 °F) and above for valve bodies. Sealing system components may have other temperature limitations.

5.2 Design Criteria

5.2.1 General

The manufacturer shall document the design criteria and analysis for each type of valve produced under this standard. This documentation shall include loading conditions that will initiate material yield for the valve body with minimum material properties and tolerances under combined loading, including tension, internal pressure, and torsion. Body material yield loading conditions shall be documented in either tabular or graphical form. The minimum design yield safety factor shall be 1.0 at the shell test pressure found in [Table C.1](#) ([Table D.1](#)).

For the valve to have a useful fatigue life, loading conditions should be monitored to ensure they remain well below manufacturer supplied valve body material yield conditions. Endurance load conditions, below which fatigue does not accumulate, will depend on the service conditions that are primarily determined by the temperature and corrosive nature of the fluids in contact with the valve.

5.2.2 Material Requirements

Where material requirements are not otherwise specified, material for equipment supplied to this standard may vary depending on the application but shall comply with the manufacturer's written specifications. Manufacturer specifications shall define the following:

- a) chemical composition limits;
- b) heat treatment conditions;
- c) limits for the following mechanical properties:
 - 1) tensile strength;
 - 2) yield strength;
 - 3) elongation; and
 - 4) hardness.

Minimum values for mechanical properties shall conform to material requirements for drill collars as specified in [Section 8](#).

5.2.3 Impact Strength

5.2.3.1 Test Specimen

Three longitudinal impact test specimens per heat per heat treatment lot shall be tested in accordance with ASTM A370 or ASTM E23. Qualification test coupons may be integral with or separate from the components they represent, or as a sacrificial production part. In all cases, test coupons shall be from the same heat as the components which they qualify and shall be heat-treated with the components.

Test specimens shall be removed from integral or separate qualification test coupons such that their longitudinal centerline axis is wholly within the center $\frac{1}{4}$ -thickness envelope for a solid test coupon or within 3 mm (1/8 in.) of the mid-thickness of the thickest section of a hollow test coupon.

Test specimens taken from sacrificial production parts shall be removed from the center $\frac{1}{4}$ -thickness envelope location of the thickest section of the part.

If the test coupon is obtained from a trepanned core or other portion removed from a production part, the test coupon shall only qualify production parts that are identical in size and shape to the production part from which it was removed.

5.2.3.2 Requirements

The average impact value of the three specimens shall not be less than 42 J (31 ft-lbs), with no single value below 32 J (24 ft-lbs). Testing shall be at -20°C (-4°F) or less.

5.2.3.3 Sub-size Specimens

If it is necessary for sub-size impact test specimens to be used, the acceptance criteria shall be multiplied by the appropriate adjustment factor listed in [Table C.2](#) ([Table D.2](#)). Sub-size test specimens of width less than 5 mm (0.197 in.) shall not be permitted.

5.2.4 Service-class Pressure Sealing Performance Requirements

Kelly valve and other drill stem safety valves (regardless of closure mechanism) shall be designed for either surface only or for both surface and downhole service. Upper kelly valves shall be classified as class 1 or class 2 depending on which design performance requirements the valve meets. Lower kelly valves and lower safety valves used with overhead drilling systems shall be designed for down-hole service and shall meet the design performance requirements for class 2-service. The design performance requirements for pressure sealing for each service class are shown in [Table C.3](#) ([Table D.3](#)).

5.2.5 Basic Design Performance Requirements

Kelly valves and other drill stem safety valves (regardless of closure mechanism) shall be designed to meet the following basic performance requirements:

- a) operation in drilling mud;
- b) closing to shut off a mud flow from the drill stem; and
- c) sealing over the design range of temperature and tension load conditions.

5.3 Hydrostatic Testing

5.3.1 General

The manufacturer shall have or have access to a facility certified for high pressure testing. Pressure testing of the end connections on the valve is not required. See [Table C.1](#) ([Table D.1](#)).

Hydrostatic testing shall be conducted to the pressures as shown in [Table C.1](#) ([Table D.1](#)). Testing shall be conducted at ambient temperature with a non-corrosive, low viscosity, low compressibility fluid. During the pressure-holding period, timing shall start when pressure stabilization is achieved. During the test period, no visually detectable leakage is permitted, and pressure drop shall be within manufacturer's tolerance for a zero leak rate.

5.3.2 Hydrostatic Shell Testing

Hydrostatic shell testing shall be conducted with the valve in the half-closed position. If there is a stem seal in the valve body, a low pressure test to 1.7 MPa (250 psi) shall also be conducted. Each new valve body shall be tested to the hydrostatic shell test pressure by the method outlined below, where both the low pressure and the high pressure tests shall be conducted in three parts:

- a) initial pressure-holding period of 3 min;
- b) reduction of pressure to zero; and
- c) re-build pressure to required final value and end test with valve body holding pressure for a period of not less than 10 min.

5.3.3 Tests at Working Pressure

5.3.3.1 General

Each valve shall be tested to the working pressure to which it is rated, depending on its class of service as defined in [Table C.3](#) ([Table D.3](#)). This testing shall apply to all new valves and shall be conducted as specified in [5.3.3.2](#) and [5.3.3.3](#).

Working pressure test period shall be for a minimum of 5 min.

5.3.3.2 Tests at Pressure from Below

This testing applies to both class 1-type and class 2-type valves.

Pressure shall be applied to the functional lower end of the valve (normally the pin end) with the valve in the closed position.

Low and high pressure tests shall be conducted. The low pressure test shall be at 1.7 MPa (250 psi) and the high pressure test shall be at the maximum working pressure rating. Open and close the valve after the high pressure test to release any trapped pressure in cavities of valve.

5.3.3.3 Tests at Pressure from Above

CAUTION—After working pressure tests are completed, check to ensure that the alignment of the ball or flapper when in the indicated “open position” is still within manufacturing tolerances, as misalignment can cause fluid erosion problems in field applications.

This testing applies to class 2-type valves only.

This testing applies to valves with ball-type closure mechanisms only.

Pressure shall be applied to the functional upper end of the valve (normally the box end) with the valve in the closed position. Low and high pressure tests shall be conducted. The low pressure test shall be at 1.7 MPa (250 psi) and the high pressure test shall be at the maximum working pressure rating. Open and close the valve after the high pressure test to release any trapped pressure in cavities of the valve, and then repeat the low pressure test.

5.3.4 Design Verification Test for Stem Seal External Pressure

Each class 2-service valve design shall have appropriate stem seal external pressure testing as outlined below:

- a) The test period shall be for a minimum of 5 min.
- b) The stem-seal external pressure test applies to class 2-type valves only and is only required for design verification purposes.
 - 1) Pressure shall be applied to the outside of the valve (e.g. through a high pressure sleeve mounted over the stem seal area) with the valve in the half-open position.
 - 2) Low and high pressure stem-seal tests shall be conducted.
 - 3) The low pressure test shall be at 1.7 MPa (250 psi) and the high pressure test shall be a minimum of 13.8 MPa (2000 psi) but may be higher (up to the rated working pressure) at the manufacturer's discretion.

5.3.5 Design Verification Test for Sealing Temperature Range

This applies to class 2-type valves only and is only required for design verification purposes.

Non-metallic seal systems are available for operation over a temperature range of -10°C (14°F) to 90°C (194°F), so design verification testing shall be conducted with the valve and the test fluid at these temperature extremes, unless the purchaser specifies otherwise. Pressure testing shall be performed in accordance with 5.3.3 and 5.3.4 at both low and high temperatures, using suitable testing fluids for extreme temperature conditions.

5.4 Connections

5.4.1 General

All valves covered by this standard shall be furnished by the manufacturer with end connections.

5.4.2 Preferred Connections

5.4.2.1 General—Size and Style

The preferred end connections on all valves shall be of the size and style indicated in [5.4.2.2](#) for the valve type.

5.4.2.2 Upper Kelly Valves

Preferred connections on upper kelly valves shall be of the size and style shown in [Section 6](#), and column 3 of [Table C.5](#) ([Table D.5](#)) and [Table C.7](#) ([Table D.7](#)) of this standard.

5.4.2.3 Lower Kelly Valves

5.4.2.3.1 Upper Connection on Lower Kelly Valves

Preferred upper connections on lower kelly valves shall be of the size and style shown in [Section 6](#), and column 7 of [Table C.5](#) ([Table D.5](#)) and [Table C.7](#) ([Table D.7](#)) of this standard.

5.4.2.3.2 Lower Connection on Lower Kelly Valves

Preferred lower connections on lower kelly valves shall be of the size and style of any connection shown in [Table C.5](#) ([Table D.5](#)), [Table C.7](#) ([Table D.7](#)), [Table C.14](#) ([Table D.14](#)), and [Table C.27](#) ([Table D.27](#)) of this standard. The NC40 and $6\frac{5}{8}$ FH connections are also acceptable.

5.4.2.4 Connections on Other Drill Stem Safety Valves

Preferred connections on other drill stem safety valves shall be of the size and style of any connection shown in [Table C.5 \(Table D.5\)](#), [Table C.7 \(Table D.7\)](#), [Table C.14 \(Table D.14\)](#), and [Table C.27 \(Table D.27\)](#) of this standard. The NC40 and 6-⁵/₈ FH connections are also acceptable.

5.4.3 Non-preferred Connection

Connections stated on the purchase order that are not listed in the tables of this standard for each valve type shall be identified as non-preferred (NPC) for these applications.

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

5.4.4 Bevel Diameters

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

5.4.5 Surface Treatment of Threads and Sealing Shoulders for Galling

To help with galling problems that could occur during usage, a treatment of zinc or manganese or zinc-and-manganese phosphate shall be applied to the threads and the sealing shoulders for all end connections of kelly valves and on 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.

Surface treatments to lessen the effect of galling are not readily available for non-magnetic materials, therefore not required.

5.4.6 Cold Working of Thread Roots

Cold working of threads is optional. However, any necessary cold working of thread should be performed after thread gauging. See [8.1.7.3](#) for further details.

5.5 Non-destructive Examination of Connections

5.5.1 Coverage

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

5.5.2 Connections from Standard Steel

Connections manufactured from standard steel shall be examined by the wet magnetic particle method. The examination shall be performed according to a written procedure developed by the manufacturer. The procedure shall be in accordance with ASTM E3024 and shall be made available to the purchaser on request.

5.5.3 Connections from Non-magnetic Steel

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 performed according to a written procedure developed by the manufacturer. The procedure shall be in accordance with either ASTM E1209, ASTM E1219, ASTM E1220, or ASTM E1418, and shall be made available to the purchaser on request.

5.6 Documentation and Retention of Records

The manufacturer shall maintain, and provide on request to the purchaser, documentation of inspection (dimensional, visual, and non-destructive), and hydrostatic testing for each valve supplied. The manufacturer shall

shall maintain documentation of performance verification testing for a period not less than seven years after the last model is sold.

5.7 Marking

5.7.1 General

Kelly valves and other drill stem safety valves manufactured in accordance with this standard shall be imprinted using low stress steel stamps or a low stress milling process.

5.7.2 All Valves with Only Preferred End Connections

Valves furnished by the valve manufacturer with all connections listed in the tables referenced in [5.4.2](#), [5.4.3](#), [5.4.4](#), and [5.4.5](#) shall be marked with the following information:

- a) the manufacturer's name or mark;
- b) "API 7-1";
- c) date of manufacture (month [xx]/year[yy]);
- d) class of service;
- e) unique serial number;
- f) maximum rated working pressure, to be applied in milled recess;
- g) the connection size and style applied on the OD surface within 127 mm (5 in.) of the connection, but no marking shall be applied to the sealing face or the face bevel;
- h) place on the OD surface, within 76 mm (3 in.) of each valve's operating mechanism, an indication of the rotation direction required to turn the flow shutoff mechanism to the closed position; and
- i) on class 1-type valves, indication of normal mud flow direction marked with an arrow (→) and the word "Flow".

5.7.3 All Valves with at Least One Non-preferred Connection

End connections that are not listed in [Table C.5 \(Table D.5\)](#), [Table C.7 \(Table D.7\)](#), [Table C.14 \(Table D.14\)](#), and [Table C.27 \(Table D.27\)](#), or the NC40 and 6-⁵/₈ FH, shall be identified as non-preferred. Non-preferred connections are not a part of this standard.

On upper and lower kelly valves and other drill stem safety valves with one or more non-preferred connections (NPC), only the valve body, valve operating mechanism, and the preferred connection specified in [Table C.5 \(Table D.5\)](#), [Table C.7 \(Table D.7\)](#), [Table C.14 \(Table D.14\)](#), and [Table C.27 \(Table D.27\)](#), or the NC40 and 6-⁵/₈ FH, are covered by this standard.

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 standard.

Valves furnished by the valve manufacturer with one or more non-preferred connections shall be marked with the following information:

- a) the manufacturer's name or mark;
- b) "API 7-1";

- c) the letters “NPC”;
- d) class of service;
- e) unique serial number;
- f) date of manufacture (month/year);
- g) maximum rated working pressure, to be applied in milled recess;
- h) the connection size and style applied on the OD surface within 127 mm (5 in.) of the connection, but no marking shall be applied to the sealing face or the face bevel;
- i) place on the OD surface, within 76 mm (3 in.) of each valve’s operating mechanism, an indication of the rotation direction required to turn the flow shutoff mechanism to the closed position; and
- j) on class 1-type valves, an indication of normal mud flow direction marked with an arrow (→) and the word “Flow”.

5.7.4 All Valves with No Preferred End Connections

End connections that are not listed in [Table C.5 \(Table D.5\)](#), [Table C.7 \(Table D.7\)](#), [Table C.14 \(Table D.14\)](#), and [Table C.27 \(Table D.27\)](#), or the NC40 and 6–5/8 FH, shall be identified as non-preferred. Non-preferred connections are not a part of this standard.

On upper and lower kelly valves and other drill stem safety valves with no preferred connections, only the valve and the valve operating mechanism are covered this standard.

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

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

- a) the manufacturer’s name or mark;
- b) “API 7-1”;
- 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 within 127 mm (5 in.) of the connection, but no marking shall be applied to the sealing face or the face bevel;
- i) place on the OD surface, within 76 mm (3 in.) of each valve’s operating mechanism, an indication of the rotation direction required to turn the flow shutoff mechanism to the closed position; and
- j) on class 1-type valves, an indication of normal mud flow direction, marked with an arrow (→) and the word “Flow”.

5.8 Supplementary Requirements

5.8.1 General

The following supplementary requirements for kelly valves and other types of drill stem safety valves shall apply by agreement between the purchaser and the manufacturer and when specified on the purchase order.

5.8.2 Performance Verification Testing of Gas-tight Sealing

Supplementary performance verification testing of drill-stem safety valves designed and manufactured in accordance with this standard shall be performed or certified, or both by a quality organization independent of the design function. Since leak testing at high pressure is potentially more hazardous with gas than with fluids of low compressibility, gas testing at high pressure shall be restricted to performance verification testing. It is recommended that Nitrogen or another non-flammable gas be used at ambient-temperature conditions. Otherwise, testing at low and high pressures shall be conducted in accordance with [5.3.3](#). No gas bubbles shall be observed in a 5-minute test period.

For each valve manufactured to the same specifications as a valve that has been designed and verified as being capable of gas-tight sealing, a gas test at a low pressure to 0.62 MPa (90 psi), and at ambient-temperature, shall be performed in accordance with in [5.3.3](#). No gas bubbles shall be observed in a 5-minute test period.

5.8.3 Supplementary Requirements for H₂S-trim

If valve trim materials conform to the requirements of NACE MR0175/ISO 15156 for H₂S service at conditions specified by the manufacturer, the valve shall be designated "H₂S-trim". H₂S-trim may be requested as a supplementary requirement by the purchaser.

H₂S-trim valves shall not be deemed suitable for use in a sour environment, as defined in NACE MR0175/ISO 15156 since the material used in the body of H₂S-trim valves is not suitable for sour service.

5.8.4 Supplementary Marking

Supplementary performance verification testing information shall be applied in a separate milled recess. Designations shall be used to indicate verified performance as follows:

- a) successful gas-tight sealing supplemental testing: "Gas-tight"; and
- b) H₂S-trim supplemental requirement: "H₂S-trim".

6 Square and Hexagonal Kellys

6.1 Size, Type, and Dimensions

Kellys shall be either square or hexagonal and conform to the sizes and dimensions in [Table C.4](#) ([Table D.4](#)), [Table C.5](#) ([Table D.5](#)), and [Figure 2](#) for square kellys; or [Table C.6](#) ([Table D.6](#)), [Table C.7](#) ([Table D.7](#)), and [Figure 3](#) for hexagonal kellys.

6.2 Dimensional Gauging

6.2.1 Drive Section

The drive section of all kellys shall be gauged for dimensional accuracy by using a sleeve gauge conforming to [Table C.8](#) ([Table D.8](#)) and [Figure 4](#).

6.2.2 Bore

All kelly bores shall be gauged with a drift mandrel 3.05 m (10 ft) long minimum. The drift mandrel shall have a minimum diameter equal to the specified bore of the kelly (standard or optional) minus $[-]$ 3.2 mm ($\frac{1}{8}$ in.).

For 133.4 mm ($5\frac{1}{4}$ in.) hexagonal kellys, a standard or optional inside diameter (bore) may be specified. See [Table C.7](#) ([Table D.7](#)) for the optional bore.

6.3 Connections

Kellys shall be furnished with box and pin connections in the sizes and styles stipulated in [Table C.5](#) ([Table D.5](#)) or [Table C.7](#) ([Table D.7](#)) and shall conform to the requirements of API 7-2.

For the lower end of 108 mm ($4\frac{1}{4}$ in.) and 133.4 mm ($5\frac{1}{4}$ in.) square kellys and for the lower end of 133.4 mm ($5\frac{1}{4}$ in.) and 152.4 mm (6 in.) hexagonal kellys, two sizes and styles of connections are standard.

A treatment of zinc or manganese or zinc-and-manganese phosphate shall be applied to the threads and the sealing shoulders of both the upper and lower connections of kellys. Application of the treatment shall be after completion of all gauging. The treatment type shall be at the discretion of the manufacturer (see [5.4.5](#)).

6.4 Square Forged Kellys

Square forged kellys shall be manufactured such that the decarburized surface layer is removed in the zones defined by the radiuses joining the drive section to the upper and lower upsets and extending a minimum of 3.2 mm ($\frac{1}{8}$ in.) beyond the tangency points of the radiuses.

6.5 Mechanical Properties

6.5.1 General

The mechanical properties of kellys, as manufactured, shall comply with the requirements of [Table C.9](#) ([Table D.9](#)).

6.5.2 Tensile Requirements

Tensile 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. Specimens of diameter 12.7 mm (0.500 in.) shall be used except where there is insufficient material; in which case the next smaller standard sub-size specimen obtainable shall be used. The next standard sub-size specimens are of diameters 8.9 mm (0.350 in.) and 6.4 mm (0.250 in.).

Tensile specimens shall be taken from the lower upset of the kelly in a longitudinal direction, having the centerline of the tensile specimen 25.4 mm (1 in.) from the outside surface or mid-wall (whichever is less).

Tensile testing is not necessary or practical on the upper upset.

A minimum Brinell hardness number of 285 shall be prima facie evidence of satisfactory mechanical properties in the upper upset.

The hardness test shall be made on the OD of the upper upset in accordance with ASTM A370 and ASTM E10 for Brinell hardness tests, and ASTM A370 and ASTM E18 for Rockwell C hardness tests.

If the Rockwell C method is used the results shall be converted to Brinell for comparison to the requirement of 285 HBN stated above.

6.5.3 Impact Strength Requirements

6.5.3.1 General

Charpy V-notch impact tests shall be conducted on specimens conforming to the requirements of ASTM A370 and ASTM E23 shall be conducted at a temperature of $21\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($70\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$). Tests conducted at lower temperatures that meet the requirements stated in [6.5.3.4](#) are acceptable.

6.5.3.2 Specimens

One set of three specimens per heat per heat-treatment lot shall be tested.

Specimens shall be taken from the lower upset at 25.4 mm (1 in.) below the surface or at mid-wall, whichever is closer to the outer surface.

The specimens shall be longitudinally oriented and radially notched.

6.5.3.3 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 of less than 5 mm (0.197 in.) are not permitted.

6.5.3.4 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).

6.6 Non-destructive Examination

Each bar or tube used to manufacture kellys shall be examined for both surface and internal defects in accordance with [Section 12](#).

6.7 Marking

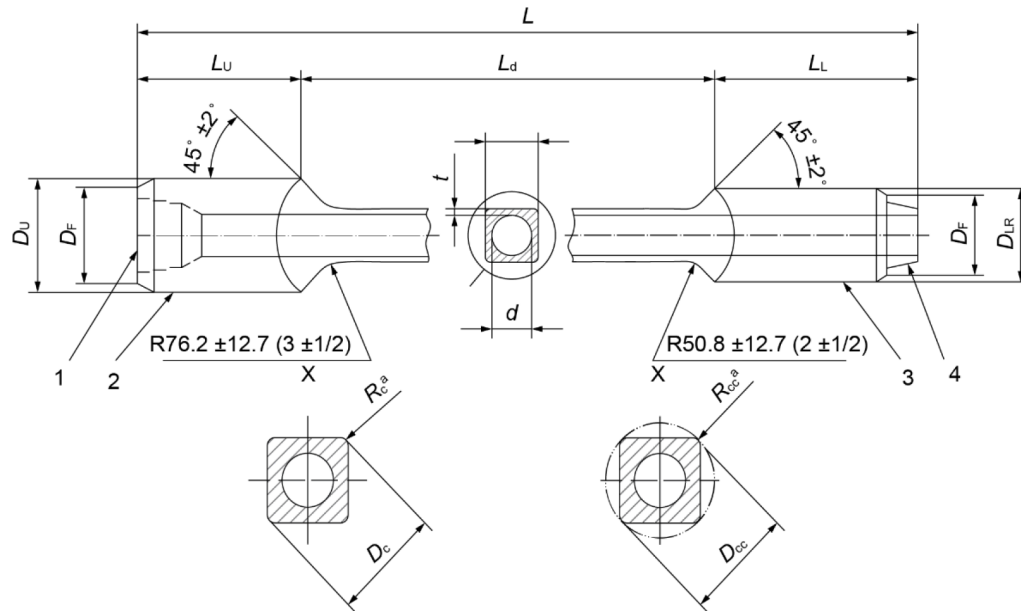
Kellys manufactured in conformance with this standard shall be die-stamped on the OD of the upper upset with the following information:

- a) manufacturer's name or identifying mark;
- b) "API 7-1"; and
- c) the size and style of the upper connection.

The lower upset shall be die-stamped on the OD with the size and style of the lower connection.

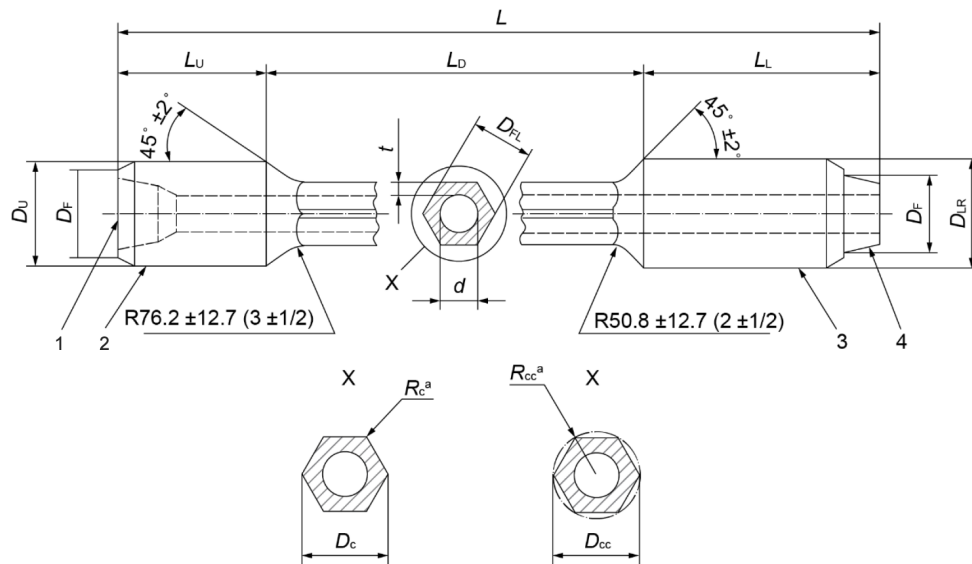
EXAMPLE—A 108 mm ($4\frac{1}{4}$ in.) square kelly with a $6\frac{5}{8}$ regular left-hand upper box connection, manufactured by AB Company, is marked:

- On upper upset: AB Co. (or mark) API 7-1, $6\frac{5}{8}$ REG LH
- On lower upset: NC50


Key

- 1 LH rotary box connection
- 2 upper upset
- 3 lower upset
- 4 RH rotary pin connection

a Corner configuration R_c or R_{cc} shall be at the manufacturer's option.

Figure 2—Square Kelly

Key

- 1 LH rotary box connection
- 2 upper upset
- 3 lower upset
- 4 RH rotary pin connection

a Corner configuration R_c or R_{cc} shall be at the manufacturer's option.

Figure 3—Hexagonal Kelly

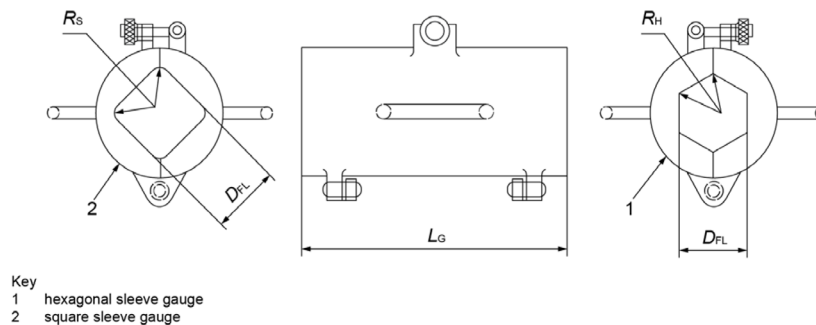


Figure 4—Sleeve Gauge for Kellys (see [Table C.8](#) or [Table D.8](#))

7 Drill Stem Subs

7.1 Class and Type

Drill stem subs shall be furnished in the classes and types shown in [Table C.10](#) ([Table D.10](#)), [Figure 5](#) and [Figure 6](#).

7.2 Dimensions for Type A and Type B

7.2.1 Connections, Bevel, and Outside Diameters

The connections shall conform to the dimensional and gauging requirements of API 7-2.

The connection sizes and styles shall conform to the applicable sizes and styles, and the bevel diameter dimensions and outside diameters shall conform to the applicable dimensions and tolerances, as follows:

- a) [Table C.5](#) ([Table D.5](#)) and [Table C.7](#) ([Table D.7](#)) when connecting to kellys;
- b) [Table C.14](#) ([Table D.14](#)) and [Table C.20](#) ([Table D.20](#)) when connecting to drill collars;
- c) [Table C.27](#) ([Table D.27](#)) when connecting to heavy-weight drill pipe;
- d) [Table C.28](#) ([Table D.28](#)), [Table C.29](#) ([Table D.29](#)), and [Table C.31](#) ([Table D.31](#)) when connecting to bits.

See API 5DP when connecting to drill pipe tool joints.

7.2.2 Inside Diameters

The inside diameters of the two connecting members shall be determined. The inside diameter (and applicable tolerances) of the Type A or Type B sub shall be equal to the smaller of the two inside diameters of these members.

7.2.3 Inside Bevel Diameter

The inside bevel diameter of the pin shall be equal to 3.2 mm $^{+1.6/0}_{0}$ mm ($1/8$ in. $^{+1/16/0}_{0}$ [$^{+0.06/0}_{0}$] in.) larger than the inside diameter specified for the corresponding connecting member.

7.2.4 Length

Lengths and tolerances for Type A and Type B drill stem subs shall be as shown in [Figure 5](#).

7.2.5 Float Valve Recess for Bit Subs

Float valve recesses are optional. If float valve recesses are specified, bit subs shall be bored to the dimensions shown in [Table C.13](#) ([Table D.13](#)) and [Figure 7](#) for the applicable assembly.

7.3 Dimensions for Type C (Swivel Subs)

7.3.1 Connections, Bevel, and Outside Diameters

The connections shall conform to the dimensional and gauging requirements of API 7-2. The connections on the swivel sub shall be pin-up and pin-down (both left-hand).

The lower pin connection size and style shall conform to the applicable sizes and styles, and the bevel diameter dimensions for the pin-down connection shall conform to the applicable dimensions and tolerances, specified in [Table C.5](#) ([Table D.5](#)) or [Table C.7](#) ([Table D.7](#)) for the upper kelly box connection. The upper connection shall be the same size and style as the swivel stem box connection, and the bevel diameter for the upper pin connection shall match the bevel diameter of the swivel stem box connection (i.e. 4-¹/₂, 6-⁵/₈, or 7-⁵/₈ API Reg).

The outside diameter and tolerances of the sub shall conform to the larger of either the kelly upper box connection or the swivel stem box connection outside diameter.

7.3.2 Inside Diameter

The maximum inside diameter shall be the largest diameter allowed for the upper kelly connection specified in [Table C.5](#) ([Table D.5](#)) or [Table C.7](#) ([Table D.7](#)). In the case of step-bored subs where the upper pin bore is larger than the lower pin bore, the upper pin bore shall not be too large to cause the upper pin to have either lower tensile or torsional strength than the lower pin as calculated in accordance with the strength and design equations of API 7G.

7.3.3 Inside Bevel Diameter

The inside bevel diameter shall be 6 mm ⁺²/₋₁ mm (¹/₄ in. ^{+1/25.4}/_{-1/12.7} [^{+0.08}/_{-0.04}] in.) larger than the inside diameter.

7.3.4 Length

The minimum tong space allowable shall be 200 mm (8 in.).

7.4 Dimensions for Type D (Lift Subs)

7.4.1 Diameter of both Lift Recess and Lift Shoulder

The diameters of the lift recess and lift shoulder shall conform as applicable to [Table C.12](#) ([Table D.12](#)).

7.4.2 Connections, Bevel, and Outside Diameters

The connection sizes and styles shall conform as applicable to [Table C.14](#) ([Table D.14](#)).

The bevel and outside diameters shall conform as applicable to [Table C.14](#) ([Table D.14](#)).

The connections shall conform to the dimensional and gauging requirements of API 7-2.

7.4.3 Inside Diameter

The maximum inside diameter shall be the largest diameter allowed for the applicable size and style of connection specified in [Table C.14](#) ([Table D.14](#)) and [Table C.21](#) ([Table D.21](#)).

7.4.4 Length

Lengths and tolerances for Type D drill stem subs shall be as shown in [Figure 6](#).

7.5 Mechanical Properties

7.5.1 Tensile Requirements

The tensile properties of Type A and Type C subs and the larger-diameter section of Type B and Type D subs shall conform to the tensile requirements of drill collars as specified in [8.2](#).

On Type B subs with turned-OD's, the original test results may not be indicative of the tensile properties of the reduced-section. On Type B subs, destructive determination of tensile properties by testing is not necessary on the reduced-diameter section.

7.5.2 Hardness Requirements

A Brinell hardness reading as specified in [Table C.11](#) ([Table D.11](#)) shall be prima facie evidence of satisfactory mechanical properties in the section of reduced-diameter. The surface hardness of the as-manufactured reduced-diameter section of Type B and Type D subs shall be measured in accordance with ASTM A370 and ASTM E10.

7.5.3 Impact Strength Requirements

7.5.3.1 General

Charpy V-notch impact tests shall be conducted on specimens conforming to the requirements of ASTM A370 and ASTM E23 and shall be conducted at a temperature of $21\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($70\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$). Tests conducted at lower temperatures that meet the requirements stated in [7.5.3.4](#) are acceptable.

7.5.3.2 Specimens

One set of three specimens per heat per heat treatment lot shall be tested.

Specimens shall be taken from the lower upset at 25.4 mm (1 in.) below the outside surface or at a depth equal to the distance from the outside surface to the mid-wall radius, whichever is closer to the outside surface.

The mid-wall radius shall be located at a depth below the outside surface defined by the following:

- a) For tubes, the depth from the outside surface to the mid-wall radius = $(\text{OD-ID})/4$,
- b) For solid bars, the depth from the outside surface to the mid-wall radius = $\text{OD}/4$.

The tolerances on the depths of testing shall be $^{+6.35}/_0\text{ mm}$ ($^{+0.250}/_0\text{ in.}$).

The specimens shall be longitudinally-oriented and radially-notched.

7.5.3.3 Specimen Size

Specimens of full-size 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 in [Table C.2](#) ([Table D.2](#)). Sub-size test specimens of less than $\leq 5\text{ mm}$ (0.197 in.) are not permitted.

7.5.3.4 Acceptance Criteria

The average impact strength of the three specimens shall be 54 J (40 ft-lbs) or greater, with no single value less than [$<$] 47 J (35 ft-lbs).

7.6 Non-destructive Examination

All bars or tubes used to manufacture drill stem subs shall be examined for both surface and internal defects in accordance with [Section 12](#). Materials containing defects shall not be used to manufacture drill stem subs.

7.7 Connection Stress-relief Features

Stress-relief features are optional on Type A and B subs and mandatory on Type C subs which are 4- $\frac{1}{2}$ API Reg and larger. Stress-relief features on Type D subs is not recommended.

The dimensions and tolerances of the stress-relief features for connections on Type A, B, and C subs shown in [Table C.10](#) ([Table D.10](#)) shall conform to the dimensions and tolerances in API 7.2.

7.8 Cold Working of Thread Roots

Cold working of thread roots is optional on Type A, B, and C subs. Cold working of thread roots on Type D subs is not recommended. See [8.1.7.3](#) for details.

7.9 Surface Treatment of Threads and Sealing Shoulders for Galling

A treatment of zinc or manganese or zinc-and-manganese phosphate shall be applied to the threads and the sealing shoulders of both the upper and lower connections of drill stem subs. The treatment type shall be at the discretion of the manufacturer.

Application of the treatment shall be after completion of all gauging.

7.10 Marking

Subs manufactured in conformance with this standard shall be marked with the following information:

- a) the manufacturer's name or identification mark;
- b) "API 7-1";
- c) the inside diameter; and
- d) the size and style of the connection at each end.

The marking shall be die-stamped on a marking recess located on the outside diameter of the sub. The marking identifying the size and style of the connection shall be placed on that end of the recess closest to the connection to which it applies. The marking recess location is shown in [Figure 5](#).

EXAMPLE 1—A sub with 4- $\frac{1}{2}$ Reg LH box connection on each end and with a 57.2 mm (2- $\frac{1}{4}$ in.) inside diameter, manufactured by AB Company, is marked as follows:

- AB Co. (or mark), API 7-1;
- 4- $\frac{1}{2}$ REG LH 57.2 4- $\frac{1}{2}$ REG LH; or
- AB Co. (or mark), API 7-1;
- 4- $\frac{1}{2}$ REG LH 2- $\frac{1}{4}$, 4- $\frac{1}{2}$ REG LH.

EXAMPLE 2—A sub with NC31 pin connection on one end and NC46 box connection on the other end and with a 50.8 mm (2 in.) inside diameter, manufactured by AB Company, is marked as follows:

- AB Co. (or mark) API 7-1;
- NC31 50.8, NC46; or
- AB Co. (or mark) API 7-1;
- NC31 2, NC46.