API Ballot id# 5466
SC5 TGDSE

Work Item	7001—Development of RP 7G-1 from RP 7G split.
Distribution-type (Ballot, Comment-only Ballot, Recirculation, Reballot, etc.)	Ballot (voting and commenting)
Impacted Documents	SPEC 7-1, SPEC 5DP, RP 7G-2
Revision Key	NA—See the **Attention-note** below for information and awareness.

Work Item Charge: Provide performance properties and calculation methods for products in Spec 7-1, Spec 5DP, and others listed in RP 7G-2.

Ballot Rationale: RP 7G (16th Ed.) is for used drill stem equipment which has not had much maintenance and is being split in to three parts (7G-1, 7G-2, 7G-3). Its scope covers inspection, performance properties, and several other issues relating to design and use of the equipment.

It was decided to have the performance properties covered by 7G-1, the inspection related content addressed by 7G-2 (already moved), and the remaining content placed in 7G-3 for the general use and operational aspects.

ATTENTION—Typically, the ballot would show the proposed updates in Track Changes. But with the current version of 7G in the old two-column style and only in a pdf-form, and with 7G-2 published, this draft of 7G-1 is essentially a "new" document and fully open during the ballot. As such, at this point there would not be enough benefit in utilizing the resources it would take to regenerate 7G into an editable version and current format/style, and incorporate the changes per 7G-2 and then those proposed from this work item.

NOTE See the ballot email notification for additional information regarding this ballot.

Ballot Content Below

Drill Stem Performance Properties ~~Design and Operating Limits~~

API RECOMMENDED PRACTICE 7G-1

~~SIXTENTH~~SEVENTENTH EDITION, ~~AUGUST 1998~~ [MONTH] [202X]

The *Special Notes*, *Foreword*, and *Contents* will be inserted by API during the page proofing stage prior to publication.

Drill Stem Performance Properties

1 Scope

This standard includes the performance properties for drill stem elements. Section 4 gives general cautions regarding the use of the performance properties included in this standard.

Sections 5, 6, 7, 8, 9, and 10 give the properties of drill pipe and tool joints, drill collars, heavy weight drill pipe, kellys, rock bits, and lift subs. Section 11 gives the properties of rotary shoulder connections and associated special processes, and Section 12 provides break-in steps.

2 Normative References

This standard contains no normative references. For a list of associated documents, see the Bibliography.

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

For the purposes of this standard, the following definitions apply.

3.1.1
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 divided by the section modulus of the rotary shouldered pin at the last engaged thread.

3.1.2
bevel diameter
The outer diameter of the contact face of the rotary shouldered connection.

3.1.3
bit sub
A sub, usually with 2 box connections, that is used to connect the bit to the drill string.

3.1.4
box connection
A threaded connection on oil country tubular goods (OCTG) that has internal threads.

3.1.5
calibration system
A documented system of gauge calibration and control.

3.1.6
Class 2
An API service classification for used drill pipe and tubing work strings.

3.1.7
cold working
Plastic deformation of metal at a temperature low enough to ensure or cause permanent strain.

3.1.8
corrosion
The alteration and degradation of material by its environment.

3.1.9
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.

3.1.10
dedendum
The distance between the pitch line and root of thread.

3.1.11
drift
A drift is a gauge to check minimum ID of loops, flow lines, nipples, tubing, casing, drill pipe, and drill collars.

3.1.12
drill collar
Thick-walled pipe or tube designed to provide stiffness and concentration of weight at the bit.

3.1.13
drill pipe
A length of tube, usually steel, to which special threaded connections called tool joints are attached.

3.1.14
drill string element
Drill pipe with tool joints attached.

3.1.15
failure
Improper performance of a device or equipment that prevents completion of its design function.

3.1.16
forging
Plastically deforming metal, usually hot, into desired shapes with compressive force, with or without dies; a shaped metal part formed by the forging method.

3.1.17
kelly
The square or hexagonal shaped steel pipe connecting the swivel to the drill string.

NOTE The kelly moves through the rotary table and transmits torque to the drill string.

3.1.18
last engaged thread
The last thread on the pin engaged with the box or the box engaged with the pin.

3.1.19
make-up shoulder
The sealing shoulder on a rotary shouldered connection.

3.1.20
minimum make-up torque
The minimum make-up torque is the minimum amount of torque necessary to develop an arbitrarily derived tensile stress in the pin or compressive stress in the box.

NOTE This arbitrarily derived stress level is perceived as being sufficient in most drilling conditions to prevent downhole make-up and to prevent shoulder separation from bending loads.

3.1.21
minimum OD
For tool joints on drill pipe with rotary shouldered connections, the minimum OD is the minimum box OD that will allow the connection to remain as strong as a specified percentage of the drill pipe tube in torsion.

3.1.22
pin end
A threaded connection on oil country tubular goods (OCTG) that has external threads.

3.1.23
plain end
Drill pipe, tubing, or casing without threads.

NOTE The pipe ends may or may not be upset.

3.1.24
Premium Class
An API service classification for used drill pipe and tubing work strings.

3.1.25
quenched and tempered
— Quenching is the hardening a ferrous alloy by austenitizing and then cooling rapidly enough so that some or all of the austenite transforms to martensite.

— Tempering is the reheating a quenched-hardened or normalized ferrous alloy to a temperature below the transformation range and then cooling at any rate desired.

3.1.26
range
A length classification for oil country tubular goods (OCTG).

3.1.27
rotary shouldered connection
A connection used on drill string elements which has coarse, tapered threads and sealing shoulders.

3.1.28
shear strength
The stress required to produce fracture in the plane of cross section, the conditions of loading being such that the directions of force and of resistance are parallel and opposite although their paths are offset a specified minimum amount; the maximum load divided by the original cross-sectional area of a section separated by shear.

3.1.29
slip area
The slip area is contained within a distance of 48 in. along the pipe body from the juncture of the tool joint OD and the elevator shoulder.

3.1.30
stress-relief feature
A modification performed on rotary shouldered connections that removes the unengaged threads of the pin or box.

NOTE This process makes the joint more flexible and reduces the likelihood of fatigue cracking in this high-stress area.

3.1.31
tensile strength
The maximum tensile stress that a material is capable of sustaining.

NOTE Tensile strength is calculated from the maximum load during a tension test carried to rupture and the original cross-sectional area of the specimen.

3.1.32
thread form
The form of thread is the thread profile in an axial plane for a length of one pitch.

3.1.33
tolerance
The amount of variation permitted.

3.1.34
tool joint
A heavy coupling element for drill pipe having coarse, tapered threads and sealing shoulders designed to sustain the weight of the drill stem, withstand the strain of repeated make-up and breakout, resist fatigue, resist additional make-up during drilling, and provide a leak-proof seal.

NOTE The pin end is attached to one end of a length of drill pipe and the box end is attached to the other end; tool joints may be welded to the drill pipe, screwed onto the pipe, or a combination of screwed on and welded.

3.1.35
upset
A pipe end with increased wall thickness.

NOTE The outside diameter may be increased, or the inside diameter may be reduced, or both; upsets are usually formed by hot forging the pipe end.

3.2 Abbreviations

DSL	double stream line
EH, XH	extra hole
FH	full hole
IF	internal flush
MOP	margin of overpull
NC	numbered connection
OHSW	open hole standard weight
OHLW	open hole light weight
SH, SLH	slim hole

4 General Information

4.1 Safety Factors

The values of performance properties included in this standard do not include factors of safety and are generally based on single loading conditions, tension only for example. In the design of drill stems, the effect of combined loading should be considered, and factors of safety should be used as are considered necessary for the particular application.

4.2 Historical Precedent of Values

The values of performance properties included in this standard have been established over time. In some cases, they are different than if calculated using the methods provided within. Generally, these are very small differences which are insignificant. This is often due to using less significant figures and rounding at different stages. These values have historical precedent and are used elsewhere, therefore they have been left unchanged unless found to be clearly in error.

4.3 Welding

Usually the materials used in the manufacture of downhole drilling equipment (tool joints, drill collars, stabilizers, and subs) are AISI 4135, 4137, 4140, or 4145 steels. These are alloy steels and are normally in the heat-treated state; these materials are not weldable unless proper procedures are used to prevent cracking and to recondition the sections where welding has been performed.

It should be emphasized that areas welded can only be reconditioned and cannot be restored to their original state free of metallurgical change unless a complete heat treatment is performed after welding, which cannot be done in the field. Performance properties in or near welded areas may be less than provided within this standard.

5 Properties of Drill Pipe and Tool Joints

The dimensional, mechanical, and performance properties of new and used drill pipe are presented in a series of tables (Table A.1 through Table A.4). Tables are also included listing these properties for tool joints used with new and used drill pipe.

The torsional strength of a tool joint is a function of several variables. These include the strength of the steel, connection size, thread form, lead, taper and coefficient of friction on mating surfaces, threads, or shoulders. The coefficient of friction for the purposes of this standard is assumed a constant; it has been demonstrated, however, that new tool joints and service temperature often affect the coefficient of friction of the tool joint system. While new tool joints typically exhibit a low coefficient of friction, service temperatures greater than 300 °F can dramatically increase or decrease the coefficient of friction depending primarily on thread compound.

The pin or box area, whichever controls, is the largest factor and is subject to the widest variation. The tool joint outside diameter (OD) and inside diameter (ID) largely determine the strength of the joint in torsion. The OD affects the box area and the ID affects the pin area. Choice of OD and ID determines the areas of the pin and box and establishes the theoretical torsional strength, assuming all other factors are constant.

The greatest reduction in theoretical torsional strength of a tool joint during its service life occurs with OD wear. At whatever point the tool joint box area becomes the smaller or controlling area, any further reduction in OD causes a direct reduction in torsional strength. If the box area controls when the tool joint is new, initial OD wear reduces torsional strength. If the pin controls when new, some OD wear may occur before the torsional strength is affected. Conversely, it is possible to increase torsional strength by making joints with oversize OD and reduced ID.

Dimensional limits and properties of used pipe are listed in Table A.3 and Table 4A.. The tool joint to pipe torsional ratios that are used here (≥ 0.80) are recommendations only, and it should be realized that other combinations of dimensions may be used. A given assembly that is suitable for certain service may be inadequate for some areas and overdesigned for others.

Additionally, on used drill pipe the minimum tong space for pin tool joints shall be 75 % of the tool joint outside diameter but not less than 4 in. and the box tong space shall not be less than L_{BC} plus 1 in.

Figure A.1 through Figure A.25 show the theoretical torsional strength and recommended make-up torque curves of several commonly used tool joint connections over a wide range of inside and outside diameters.

Torsional strength is based on 120,000 psi minimum yield strength and calculated by Equation (G.10). Recommended make-up torque is based on 72,000 psi stress and calculated by Equation (G.11).

a) The theoretical torsional strength for a used tool joint is determined by taking the following steps.
   1) Select the appropriately titled curve for the size and type tool joint connection being studied.
   2) Extend a horizontal line from the OD under consideration to the curve and read the torsional strength representing the box.
   3) Extend a vertical line from the ID to the curve and read the torsional strength representing the pin.

The smaller of the two torsional strengths thus obtained is the theoretical torsional strength of the tool joint.

It is emphasized that the values obtained from the curves are theoretical values of torsional strength. Tool joints in the field, subject to many factors not included in determination of points for the curves, may vary from these values.

The curves are most useful to show the relative torsional strengths of joints for variations in OD and ID, both new and after wear. In each case, the smaller value should be used.

b) The recommended make-up torque for a used tool joint is determined by taking the following steps.
   1) Select the appropriately titled curve for the size and type tool joint connection being studied.
   2) Extend a horizontal line from the OD under consideration to the curve and read the recommended make-up torque representing the box.
   3) Extend a vertical line from the ID under consideration to the curve and read the recommended make-up torque representing the pin.

The smaller of the two recommended make-up torques thus obtained is the recommended make-up torque for the tool joint.

A make-up torque higher than recommended may be required under extreme conditions.

6 Properties of Drill Collars

6.1 Weight

Table B.1 contains steel drill collar weights for a wide range of OD and ID combinations, in both API and non-API sizes. Values in the table may be used to provide the basic information required to calculate the weights of drill collar strings that are not made up of collars having uniform and standard weights.

6.2 Make-up Torque

Recommended make-up torque values for rotary shouldered drill collar connections are listed in Table B.2. These values are listed for various connection styles and for commonly used drill collar OD and ID sizes. The table also includes a designation of the weak member (pin or box) for each connection size and style.

6.3 Bending Strenteh Ratio (BSR)

Many drill collar connection failures are a result of bending stresses rather than torsional stresses. Figure B.16 through Figure B.7 may be used for determining the most suitable connection to be used on new drill collars or for selecting the new connection to be used on collars that have been worn down on the outside diameter. The curves were determined from bending strength ratios calculated by using the section modulus (Z) as the measure of the capacity of a section to resist any bending moment to which it may be subjected. The effect of stress-relief features is disregarded. The bending strength ratio is calculated using Equation (G.12). The equation’s derivation and an example of its use are included in G.6.

The following BSR ranges may be used as guidelines in specifying acceptable BSRs. These apply best to collars with a uniform OD and ID throughout the length of the collar.

- Collar OD smaller than 6 in.:……1.80 to 2.50
- Collar OD 6 in. to 8 in.:……. …....2.25 to 2.75
- Collar OD larger than 8 in.:………2.50 to 3.20

Used drill collar dimensions are limited such that these BSR ranges are kept and by a make-up torque that is acceptable to the user.

The minimum bending strength ratio acceptable in one operating area may not be acceptable in another. Local operating practices experience based on recent predominance of failures and other conditions should be considered when determining the minimum acceptable bending strength ratio for a particular area and type of operation. For proprietary connections, consult the manufacturer's guidelines for determining bending-strength ratios.

Certain other precautions should be observed in using these charts. It is imperative that adequate shoulder width and area at the end of the pin be maintained. The calculations involving bending strength ratios are based on standard dimensions for all connections.

Minor differences between measured inside diameter and inside diameters in Figure B.16 through Figure Figure B.7 are of little significance; therefore, select the figure with the inside diameter closest to measured inside diameter.

6.4 Elevator Grooves

There is no accepted way to reasonably determine the lifting capacity of the elevator groove shoulder. Even a small amount of wear can significantly reduce the lifting capacity. Therefore, elevator grooves should not be used for lifting.

7 Properties of Heavy Weight Drill Pipe

Table C.1 provides the performance properties for heavy weight drill pipe defined in API 7-1.

Table C.2 provides the dimensional limits and performance properties for used heavy weight drill pipe. Additionally, on used HWDP a minimum of 10 in. tong space shall be present at each end and eccentric wear on the center upset is limited to $^{1}/_{8}$ in. maximum.

NOTE Properties of HWDP products outside the scope for those provided in API 7-1 are also not provided in this standard but may be obtained from their manufacturer.

8 Properties of Kellys

8.1 General

Kellys are manufactured with one of two drive configurations, square or hexagonal. Dimensions are given in API 7-1. The performance properties of new kellys is given in Table D.1 and of remachined kellys in Table D.2.

Square kellys are furnished as forged or machined in the drive section. On forged kellys, the drive sections are normalized and tempered, and the ends are quenched and tempered.

Hexagonal or fully machined square kellys are machined from round bars. Heat treatment may be either:

a) full-length quenched and tempered before machining; or

b) the drive section normalized and tempered, and the ends quenched and tempered.

It should be noted that fully quenched drive sections have higher minimum tensile yield strength than normalized drive sections when tempered to the same hardness level. For the same hardness level, the ultimate tensile strength may be considered as the same in both cases.

8.2 Selection Criteria

The following criteria should be considered in selecting square or hexagonal kellys.

a) It may be observed from Table D.1 that the drive section of the hexagonal kelly is stronger than the drive section of the square kelly when the appropriate kelly is selected for a given casing size; e.g. a $4^{1}/_{4}$-in. square kelly or a $5^{1}/_{4}$-in. hexagonal kelly would be selected for use in $8^{5}/_{8}$-in. casing.

   It may also be observed, however, that the connections on these two kellys are generally the same and unless the bores (inside diameters) are the same, the kelly with the smaller bore could be interpreted to have the greater pin tensile and torsional strength.

b) For a given tensile load, the stress level is less in the hexagonal section.

   Due to the lower stress level, the endurance limit of the hexagonal drive section is greater in terms of cycles to failure for a given bending load.

c) Surface decarburization (decarb) is inherent in the as-forged square kelly, which further reduces the endurance limit in terms of cycles to failure for a given bending load. Hexagonal kellys and fully machined squares have machined surfaces and are generally free of decarb in the drive section.

   It is impractical to remove the decarb from the complete drive section of the forged square kelly; however, the decarb should be removed from the corners in the fillet between the drive section and the upset to aid in the prevention of fatigue cracks in this area. Machining of square kellys from round bars could eliminate this undesirable condition.

d) The life of the drive section is directly related to the kelly fit with the kelly drive. A square drive section normally will tolerate a greater clearance with acceptable life than will a hexagonal section. A diligent effort by the rig personnel to maintain minimum clearance between the kelly drive section and the bushing will minimize this consideration in kelly selection.

   New roller bushing assemblies working on new kellys will develop wear patterns that are essentially flat in shape on the driving edge of the kelly. Wear patterns begin as point contacts of zero width near the corner. The pattern widens as the kelly and bushing begin to wear until a maximum wear pattern is achieved. The wear rate will be the least when the maximum wear pattern width is achieved.

   Figure D.1 illustrates the maximum width flat wear pattern that could be expected on the kelly drive flats if the new assembly has clearances as shown in Table D.3. The information in Table D.3 and Figure D.1 and Figure D.2 may be used to evaluate the clearances between kelly and bushing. This evaluation should be made as soon as a wear pattern becomes apparent after a new assembly is put into service.

   EXAMPLE—At the time of evaluation, the wear pattern width for a $5^{1}/_{4}$-in. hexagonal kelly is 1.00 in.

   This could mean one of the following two conditions exist.

   1. If the contact angle is less than 8 degrees 37 minutes, the original clearances were acceptable; in this case, the wear pattern is not fully developed.
   2. If the contact angle is greater than 8 degrees 37 minutes, the wear pattern is fully developed; in this case, the clearance is greater than is recommended and would need to be corrected.

8.3 Extending Life of Kellys—Remachining and Reversing Ends

8.3.1 Remachining

Before attempting to remachine a kelly, it should be fully inspected for fatigue cracks and also dimensionally checked to assure that it is suitable for remilling. The strength of a remachined kelly should be compared with the strength of the drill pipe with which the kelly is to be used. (See Table D.2 for drive section dimensions and strengths.)

8.3.2 Reversing Ends

Usually both ends of the kelly shall be butt welded (stubbed) for this to be possible as the original top is too short and the old lower end is too small in diameter for the connections to be reversed. The welds should be made in the upset portions on each end to insure the tensile integrity and fatigue resistance capabilities of the sections. Proper heating and welding procedures shall be used to prevent cracking and to recondition the sections where welding has been performed.

8.4 Internal Pressure at Minimum Yield

The internal pressure at minimum yield for the drive section may be calculated from Equation (G.6).

9 Classification and Properties of Rock Bits

A classification system for designating roller cone rock bits was developed by the International Association of Drilling Contractors (IADC). The system designates bits according to the type of bit (steel tooth or insert), the type of formation drilled, and mechanical features of the bit, where the classification forms may be obtained from IADC.

a) Recommended Torque

Recommended torque for fixed cutter bits is shown in Table E.1. Recommended torque for roller cone bits is shown in Table E.2.

b) Common Bit Sizes

Common sizes for roller bits are listed in Table E.3. Common sizes for fixed cutter bits are listed in Table E.4. Other sizes may be available by request from the manufacturer.

10 Properties of Lift Subs—Yield Load

The yield load for lift subs manufactured according to API 7-1 is provided in Table F.1. A safety factor should be applied to determine the safe working load.

11 Properties of Rotary Shouldered Connections

11.1 Purpose

The threads on rotary-shouldered connection do not form a seal, but act as a jack-screw to force the shoulders together. By forcing the shoulders together under high load, the shoulders provide the necessary seal to prevent leakage.

The connection acts as a structural member in the drilling assembly. This means that the connection shall be strong in torsion, tension, and bending; strong in torsion to take the rotational forces as the bit turns, strong enough in tension to lift the drill string from the hole, and strong in bending strength to resist fatigue failures.

The rotary shouldered connection is designed with the best overall combination of these functions to utilize the tensile and torsional strength of the steel, maximum possible stiffness, and shoulder sealing efficiency.

The ideal condition would be to have the connection as stiff and strong as the body of the drill stem member of which it is a part. Since this is not practical, design calculations are made to obtain the best balance between relative capacities of the box and pin to resist bending; the best torsional balance to give optimum shoulder load to prevent shoulder separation and to provide ample tensile load requirements.

The shoulders acting under high compressive load form the only sealing surface. All threads on rotary shouldered connections are purposely truncated to prevent interference between the thread crests and thread roots, in addition to providing a space for excess thread compound and foreign particles in the drilling fluid. The space between the box counterbore and pin base also serves this purpose.

NOTE This space between the box counterbore and pin base, as well as the space between the non-loaded thread flanks, forms a helical opening that follows the thread all the way to the bore of the connection.

The shoulders should always be treated with care and good rig practices to ensure proper sealing.

11.2 Interchangeable Connections

Many sizes and styles of connections are interchangeable with certain others. These conditions differ only in name and in some cases thread form. A table of interchangeable connections is provided in API 7-2.

11.3 Recommended Make-up Torque

Recommended make-up torque values for drill pipe tool joint connections are listed in Table A.2Table A.2, Table A.3Table A.3, and Table A.4Table A.4, and also shown in Figure A.1Figure A.1 through Figure A.25Figure A.25.

Recommended make-up torques for drill collars connections are shown in Table Table B.2; these values are listed for various connection styles and for commonly used OD and ID sizes. Most of the other bottom hole assembly components (subs, reamers, stabilizers and other tools between the drill pipe and the bit) should follow Table Table B.2 or manufacture's recommendations.

Recommended make-up torques for drill bits are provided in Table E.1 and Table Table E.2. Make-up torque is calculated using Equatio(G.11)n (G.11).

11.4 Torque to Yield

Torque to yield of drill pipe tool joint connections are listed in Table A.2Table A.2, Table A.3Table A.3,and Table A.4Table A.4. Torque to yield is calculated using Equation(G.10) (G.10).

11.5 Bending Strength Ratio (BSR)

The bending strength ratio for drill collar connections with a variety of OD's and ID's are show in Figure Figure B.1 through Figure Figure B.7. The effect of stress-relief features is disregarded when calculating the BSR. The bending strength ratio is calculated using Equation (G.12)(G.12). The equation's derivation and an example of its use are included in G.6.

11.6 Stress Relief Features

11.6.1 Relief Grooves

Stress is concentrated in the thread roots of rotary-shouldered connections. Relief grooves were designed to remove the thread roots and spread the bending over a larger area. Original laboratory fatigue tests performed by several drill collar manufacturers in the 1950's demonstrated the beneficial effects of the stress-relief grooves at the pin shoulder and at the base of the box thread.

These laboratory tests indicated an improvement by raising the fatigue life of the connections by as much as 4 to 5 fold. Subsequent tests made under actual service conditions verified the improvement in fatigue life gained if these features are provided. Finite element analysis of pin stress relief grooves in the 1990's further confirmed the benefit and established the groove length limits for new and used products.

11.6.2 Box Bore Back Relief Feature

The relief groove on the pin is easy to machine because the machinist can see his work. But machining the relief groove in the box presents problems. One of the problems of machining a relief groove in the box is the ability of the machinist to see over the thread crest and thus assure the surfaces of the groove were smooth and free of tool marks. The surface of relief features should be free of machining marks for benefits to be seen.

The bore back relief feature was designed to eliminate these problems. Instead of a groove, the bore back is cut as a cylinder with the taper of the threads causing the thread roots to gradually vanish at the back of the box.

The bore back is the preferred relief feature for the box but the box relief groove is still available as an alternate.

11.7 Torsional Balance

Torsional balance exists for a connection when the box area, A_b is equal to the pin area, A_p. It can be expressed as the A_b/A_p ratio, where A_b/A_p = 1.00 is balanced. This is ideal because the recommended make-up torque yields equal magnitude compressive stress in the box and tensile stress in the pin, and the maximum compressive stress in the box is achieved. It is this compressive stress that keeps the shoulders together.

An A_b/A_p ratio less than 1.00 is box-weak and will also have the maximum compressive stress in the box when made up to the recommended make-up torque. The stress in the box is equal to the make-up stress level, S.

An A_b/A_p ratio greater than 1.00 is pin-weak. As the ratio increases greater than 1.00, the compressive stress in the box decreases and it becomes increasingly more difficult to keep the shoulders from opening while rotating.

> EXAMPLE—If the A_b/A_p ratio is 1.20 on a drill collar connection, the average compressive stress in the box is reduced to 52,083 psi; and if the ratio is 1.50, the average compressive stress in the box will be further reduced to 41,667 psi. This may not be enough compression to offset the bending caused by rotation and other down hole conditions; where the result could be the shoulders open on the outer periphery, the thread compound is lost and galling of the shoulders and hard-to-break connections occur.

WARNING—It is critical to follow proper make-up procedures and apply the correct amount of make-up torque if the A_b/A_p ratio is greater than 1.00.

If the ratio is greater than 1.20, it may be necessary to apply more make-up torque than that which is recommended in Table B.1. The exact amount depends upon the drilling conditions. Remember the recommended range is the tabulated value to plus 10 %. If galling still persists, increase the torque in 5 % increments until the problem disappears.

In large diameter drill collars it is very difficult to select a connection where the A_b/A_p ratio is near 1.00 because the number of connections to select from is limited to a very few. The solution to this problem is to use the low torque feature to reduce box area.

11.8 Low Torque Feature

The name "low torque" is misleading. It does not reduce the make-up required for the connection unless it is used on an OD smaller than the minimum OD for which it is recommended.

It does not change the BSR discussed in 11.5 if the OD is the same. But it does permit the use of bending strength ratios as large as 3.40.

The torsional area of the box connections machined with the low torque feature is reduced because the counterbore is cut to a diameter larger than the counterbore on a standard “full faced” connection.

With the box torsional area reduced, the A_b/A_p ratio is reduced and the compressive stress in the shoulders is increased.

Caution should be used in that connections with the low torque feature should not be mated with connections with the standard “full face” because both the outside bevels and the counterbores are different. To mate such a difference will reduce the contact face by as much as 50 % causing the shoulders to yield in compression.

11.9 Cold Working

Stress is concentrated in the thread roots of a rotary shouldered connection and cyclic loading (bending while rotating) often results in fatigue. At about the same time research work was being performed on stress relief features, laboratory investigations were done as to the benefits of cold working the thread roots. The conclusions of these tests indicated almost the same improvements could be achieved by cold working the thread roots of the thread.

Cold working the thread roots raises the fatigue life of the connection by as much as four times over the limit of a non-cold worked thread. Cold working puts the thread root into a compressive state by yielding the surface of the thread root. With the surface in compression, the connection can withstand higher bending loads before fatigue begins.

Cold working can be applied by several methods: cold rolling under pressure with a roller shaped like the thread form (API 7CR), shot peening, or by working with a small special shaped air hammer.

The gauging of the connection should be done before cold working because the gauge stand-off will change. But the process will not interfere with the make-up of the connection.

12 Connection Break-in

Based on field experience, it has been observed that used rotary shouldered connections are less likely to gall than new connections. It is believed that this is due to work hardening the connection surfaces. The process of connection break-in is a make-up and break-out of the connection under controlled conditions to provide surface work hardening prior to use.

Since many factors effect connection galling, connection break-in does not eliminate the possibility of galling. Connection break-in may be done on the rig, as an optional manufacturing step, or at a service facility. The following steps should be followed during break-in.

a) Preparation for Connection Break-in

   1) Remove any storage or rust preventative coatings.

   2) Make sure that the connections are free of dirt or other debris.

   3) Thoroughly coat the threads and shoulders of both pin and box connections with a thread compound suitable for rotary shouldered connections.

   4) Determine the recommended make-up torque of the connection as described in 11.3.

b) Connection Break-in at the Rig

   1) Taking care to align the connection, stab and make-up the connection slowly.

      NOTE Galling may occur if not well aligned or spinning together with a chain or high-speed power spinner.

2) Using a calibrated torque gauge or line pull indicator, slowly make-up to the recommended make-up torque; if using manual tongs, use both sets of tongs and keep lines at 90° for the final torque.

3) Slowly break-out the connection.

During both make-up and break-out, watch for excessive resistance or other signs that could indicate the possibility of galling. Wipe clean the pin and box connections and visually inspect for evidence of galling in the threads or sealing shoulders. If galling occurs, rework the connection prior to use.

c) Connection Break-in during Manufacturing

1) Slowly make-up three-times to the recommended torque.

2) Between each make-up, break-out only far enough to apply additional thread compound to the shoulders and last engaged threads.

3) Break-out the connection after final make-up.

4) Wipe clean the pin and box and visually inspect for galling on the threads or shoulder; if galling occurs, the connection is rejected.

When performing break-in at the factory or service facility, the connection should be finished machined, inspected, cold rolled (if specified), and preferably coated with an anti-gall material such as a phosphate or copper.

NOTE Break-in will change thread gauge standoff.

Annex A
(informative)

Properties of Drill Pipe and Tool Joints

Table A.1—New Drill Pipe Body Dimensional Data

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Label 1 (in.) D_{dp}	**Label 2**	**Plain End Weight** [a] (lb/ft) w_{pe}	**Wall Thickness** (in.) t	**ID** [b] (in.) d_{dp}	**Section Area Body of Pipe** [c] (in.^{2}) A	**Polar Sectional Modulus** [d] (in.^{3}) Z
2 3/8	4.85	4.43	0.190	1.995	1.3042	1.321
	6.65	6.26	0.280	1.815	1.8429	1.733
2 7/8	6.85	6.16	0.217	2.441	1.8120	2.241
	10.40	9.72	0.362	2.151	2.8579	3.204
3 1/2	9.50	8.81	0.254	2.992	2.5902	3.923
	13.30	12.31	0.368	2.764	3.6209	5.144
	15.50	14.63	0.449	2.602	4.3037	5.847
4	11.85	10.46	0.262	3.476	3.0767	5.400
	14.00	12.93	0.330	3.340	3.8048	6.458
	15.70	14.69	0.380	3.240	4.3216	7.157
4 1/2	13.75	12.24	0.271	3.958	3.6004	7.184
	16.60	14.98	0.337	3.826	4.4074	8.543
	20.00	18.69	0.430	3.640	5.4981	10.232
	22.82	21.36	0.500	3.500	6.2832	11.345
5	16.25	14.87	0.296	4.408	4.3743	9.718
	19.50	17.93	0.362	4.276	5.2746	11.415
	25.60	24.03	0.500	4.000	7.0686	14.491
	TW 0.750	34.04	0.750	3.500	10.0138	18.651
5 1/2	19.20	16.87	0.304	4.892	4.9624	12.221
	21.90	19.81	0.361	4.778	5.8282	14.062
	24.70	22.54	0.415	4.670	6.6296	15.688
	TW 0.500	26.70	0.500	4.500	7.8540	18.028
	TW 0.625	32.54	0.625	4.250	9.5720	21.020
	TW 0.750	38.05	0.750	4.000	11.1919	23.528
5 7/8	23.4	21.26	0.361	5.153	6.2535	16.251
	26.3	24.20	0.415	5.045	7.1185	18.165
	TW 0.625	35.04	0.625	4.625	10.3084	24.523
	TW 0.750	41.05	0.750	4.375	12.0755	27.571
	TW 0.813	43.95	0.813	4.249	12.9289	28.922
6 5/8	25.20	22.19	0.330	5.965	6.5262	19.572
	27.70	24.21	0.362	5.901	7.1227	21.156
	TW 0.522	34.02	0.522	5.581	10.0084	28.340
	TW 0.625	40.05	0.625	5.375	11.7810	32.356
	TW 0.750	47.06	0.750	5.125	13.8426	36.647
	TW 0.813	50.47	0.813	4.999	14.8445	38.585

[a] Plain end weight is calculated using Equation (G.16).

[b] $d_{dp} = D_{dp} - 2t$

[c] $A = \frac{\pi}{4}(D_{dp}^{2} - d_{dp}^{2})$

[d] $Z = \frac{\pi}{16}\frac{(D_{dp}^{4} - d_{dp}^{4})}{D_{dp}}$

Table A.2—New Drill Pipe Properties

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe									
					Box OD (in.)	Pin ID (in.)	Ap-prox. Mass (lb/ft)	Make-up Torque [b,c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint [d] (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. In-ternal Pressure Pipe Body (psi)
2 3/8	4.85	E	EU	2 3/8 OH LW	3 1/8	2	4.95	2716 P	97817	206416	4763	4526 p	11040	10500
2 3/8	4.85	E	EU	2 3/8 SL H90	3 1/4	2	5.05	3042 P	97817	202670	4763	5075 p	11040	10500
2 3/8	4.85	E	EU	2 3/8 WO	3 3/8	2	5.15	2541 P	97817	195677	4763	4235 p	11040	10500
2 3/8	4.85	E	EU	NC26	3 3/8	1 3/4	5.26	4125 B	97817	313681	4763	6875 b	11040	10500
2 3/8	6.65	E	EU	2 3/8 OH LW	3 1/4	1 3/4	6.89	3783 B	138214	294620	6250	6305 b	15599	15474
2 3/8	6.65	E	IU	2 3/8 PAC *	2 7/8	1 3/8	6.71	2803 P	138214	238504	6250	4672 P	15599	15474
2 3/8	6.65	E	EU	2 3/8 SL H90	3 1/4	2	6.78	3042 P	138214	202850	6250	5075 p	15599	15474
2 3/8	6.65	E	EU	NC26	3 3/8	1 3/4	7.02	4125 B	138214	313681	6250	6875 b	15599	15474
2 3/8	6.65	X	EU	2 3/8 SL H90	3 1/4	1 13/16	6.99	4109 P	175072	270223	7917	6862 p	19759	19600
2 3/8	6.65	X	EU	NC26	3 3/8	1 3/4	7.11	4125 B	175072	313681	7917	6875 b	19759	19600
2 3/8	6.65	G	EU	2 3/8 SL H90 *	3 1/4	1 13/16	6.99	4109 P	193500	270223	8751	6862 P	21839	21663
2 3/8	6.65	G	EU	NC26 *	3 3/8	1 3/4	7.11	4125 B	193500	313681	8751	6875 b	21839	21663
2 7/8	6.85	E	EU	2 7/8 OH LW *	3 3/4	2 7/16	6.93	3290 B	135902	223937	8083	5464 P	10467	9907
2 7/8	6.85	E	EU	2 7/8 SL H90	3 7/8	2 7/16	7.05	4504 P	135902	260783	8083	7513 p	10467	9907
2 7/8	6.85	E	EU	2 7/8 WO	4 1/8	2 7/16	7.31	4209 P	135902	277553	8083	7015 p	10467	9907
2 7/8	6.85	E	EU	NC31	4 1/8	2 1/8	7.50	7074 P	135902	447130	8083	11790 p	10467	9907
2 7/8	10.40	E	EU	2 7/8 OH SW *	3 7/8	2 5/32	10.59	5194 P	214344	345566	11554	8659 P	16509	16526
2 7/8	10.40	E	IU	2 7/8 PAC *	3 1/8	1 1/2	10.27	3424 P	214344	272938	11554	5706 P	16509	16526
2 7/8	10.40	E	EU	2 7/8 SL H90	3 7/8	2 5/32	10.59	6732 P	214344	382765	11554	11227 p	16509	16526
2 7/8	10.40	E	IU	2 7/8 XH	4 1/4	1 7/8	11.19	7853 P	214344	505054	11554	13088 p	16509	16526
2 7/8	10.40	E	IU	NC26 [1]	3 3/8	1 3/4	10.35	4125 B	214344	313681	11554	6875 B	16509	16526

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe										
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
2 7/8	10.40	E	EU	NC31	4 1/8	2 1/8	10.92	7074 P	214344	447130	11554	11790 p	16509	16526
2 7/8	10.40	X	EU	2 7/8 SL H90 *	3 7/8	2 5/32	10.74	6732 P	271503	382329	14635	11208 P	20911	20933
2 7/8	10.40	X	EU	2 7/8 SL H90	4	2	10.95	7859 P	271503	443971	14635	13119 p	20911	20933
2 7/8	10.40	X	EU	NC31	4 1/8	2	11.09	7895 P	271503	495726	14635	13158 p	20911	20933
2 7/8	10.40	G	EU	2 7/8 SL H90	4	2	10.95	7859 P	300082	443971	16176	13119 p	23112	23137
2 7/8	10.40	G	EU	NC31	4 1/8	2	11.09	7895 P	300082	495726	16176	13158 p	23112	23137
2 7/8	10.40	S	EU	2 7/8 SL H90	4 1/8	1 5/8	11.26	10264 P	385820	572089	20798	17130 p	29716	29747
2 7/8	10.40	S	EU	NC31	4 3/8	1 5/8	11.55	10086 P	385820	623844	20798	16809 p	29716	29747
3 1/2	9.50	E	EU	3 1/2 OH LW	4 1/2	3	9.84	7082 P	194264	392071	14146	11803 p	10001	9525
3 1/2	9.50	E	EU	3 1/2 OH LW	4 3/4	3	10.34	7082 P	194264	392071	14146	11803 p	10001	9525
3 1/2	9.50	E	EU	3 1/2 SL H90	4 5/8	3	9.99	7469 P	194264	366705	14146	12458 p	10001	9525
3 1/2	9.50	E	EU	3 1/2 WO	4 3/4	3	10.14	7633 P	194264	419797	14146	12723 p	10001	9525
3 1/2	9.50	E	EU	NC38	4 3/4	2 11/16	10.60	10843 P	194264	587308	14146	18071 p	10001	9525
3 1/2	9.50	E	EU	NC38	4 3/4	3	10.34	7595 P	194264	419797	14146	12657 p	10001	9525
3 1/2	9.50	SS75	EU	NC38	4 3/4	2 11/16	10.72	9934 P	194264	538133	14146	16557 p	10001	9525
3 1/2	13.30	E	EU	3 1/2 H90	5 1/4	2 3/4	14.37	14043 B	271569	664050	18551	23443 p	14113	13800
3 1/2	13.30	E	EU	3 1/2 OH SW	4 3/4	2 11/16	13.75	10300 P	271569	559582	18551	17167 p	14113	13800
3 1/2	13.30	E	EU	3 1/2 XH	4 3/4	2 7/16	13.91	10120 P	271569	570939	18551	16867 p	14113	13800
3 1/2	13.30	E	IU	NC31 *	4 1/8	2 1/8	13.40	7074 P	271569	447130	18551	11790 P	14113	13800
3 1/2	13.30	E	EU	NC38	4 3/4	2 11/16	13.96	10843 P	271569	587308	18551	18071 p	14113	13800
3 1/2	13.30	SS75	EU	NC38	4 3/4	2 11/16	14.05	9934 P	271569	538133	18551	16557 p	14113	13800
3 1/2	13.30	X	EU	3 1/2 H90	5 1/4	2 3/4	14.60	14043 B	343988	664050	23498	23443 p	17877	17480
3 1/2	13.30	X	EU	3 1/2 SL H90 *	4 5/8	2 11/16	13.98	11073 P	343988	533686	23498	18438 P	17877	17480
3 1/2	13.30	X	EU	3 1/2 SL H90	4 3/4	2 9/16	14.06	12408 P	343988	596066	23498	20709 p	17877	17480

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe										
					Box OD (in.)	Pin ID (in.)	Ap-prox. Mass (lb/ft)	Make-up Torque [b,c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint [d] (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. In-ternal Pressure Pipe Body (psi)
3 1/2	13.30	X	EU	NC38	5	2 9/16	14.62	12057 P	343988	649158	23498	20095 p	17877	17480
3 1/2	13.30	SS95	EU	NC38	5	2 1/8	14.91	14577 P	343988	772236	23498	24294 p	17877	17480
3 1/2	13.30	G	EU	3 1/2 SL H90	4 3/4	2 9/16	14.06	12408 P	380197	596066	25972	20709 p	19758	19320
3 1/2	13.30	G	EU	NC38	5	2 7/16	14.72	13221 P	380197	708063	25972	22035 p	19758	19320
3 1/2	13.30	S	EU	3 1/2 SL H90	5	2 1/8	14.65	16667 P	488825	789348	33392	27809 p	25404	24840
3 1/2	13.30	S	EU	NC38	5	2 1/8	14.93	15902 P	488825	842440	33392	26503 P	25404	24840
3 1/2	13.30	S	EU	NC40	5 3/8	2 7/16	15.13	17858 P	488825	897161	33392	29764 p	25404	24840
3 1/2	13.30	V	EU	NC38 *	5	2 1/8	14.91	15902 P	543135	842440	37125	26503 P	28226	27600
3 1/2	15.50	E	EU	NC38	5	2 9/16	16.58	12057 P	322775	649158	21086	20095 p	16774	16838
3 1/2	15.50	SS75	EU	NC38	5	2 9/16	16.71	11048 P	322775	594840	21086	18413 p	16774	16838
3 1/2	15.50	X	EU	NC38	5	2 7/16	16.84	13221 P	408848	708063	26708	22035 p	21247	21328
3 1/2	15.50	SS95	EU	NC40	5 1/2	2 1/4	17.33	17982 P	408848	898330	26708	29969 p	21247	21328
3 1/2	15.50	G	EU	NC38	5	2 1/8	17.06	15902 P	451885	842440	29520	26503 p	23484	23573
3 1/2	15.50	G	EU	NC40	5 1/4	2 9/16	16.97	16616 P	451885	838257	29520	27693 p	23484	23573
3 1/2	15.50	S	EU	NC38 *	5	2 1/8	17.05	15902 P	580995	842440	37954	26503 P	30194	30308
3 1/2	15.50	S	EU	NC40	5 1/2	2 1/4	17.60	19616 P	580995	979996	37954	32693 p	30194	30308
3 1/2	15.50	V	EU	NC40 *	5 1/2	2 1/4	17.33	19616 P	645555	979996	42197	32694 P	33549	33675
4	11.85	E	IU	4 H90	5 1/2	2 13/16	13.00	21185 P	230755	913708	19474	35308 p	8381	8597
4	11.85	E	EU	4 OH LW	5 1/4	3 15/32	12.10	13186 P	230755	621357	19474	21903 p	8381	8597
4	11.85	E	EU	4 WO	5 3/4	3 7/16	12.91	17186 P	230755	782987	19474	28643 p	8381	8597
4	11.85	E	EU	NC46	6	3 1/4	13.52	19937 P	230755	901164	19474	33228 p	8381	8597
4	14.00	E	IU	4 H90	5 1/2	2 13/16	15.43	21185 P	285359	913708	23288	35308 p	11354	10828
4	14.00	E	EU	4 OH SW	5 1/2	3 1/4	15.02	16236 P	285359	759875	23288	27060 p	11354	10828
4	14.00	E	IU	4 SH *	4 5/8	2 9/16	14.35	9016 P	285359	512035	23288	15026 P	11354	10828

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe									
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4	14.00	E	IU	NC40	5 1/4	2 13/16	15.06	13968 P	285359	711611	23288	23279 p	11354	10828
4	14.00	E	EU	NC46	6	3 1/4	15.91	19937 P	285359	901164	23288	33228 p	11354	10828
4	14.00	SS75	EU	NC46	6	3 1/4	15.89	18275 P	285359	826067	23288	30459 p	11354	10828
4	14.00	X	IU	4 H90	5 1/2	2 13/16	15.63	21185 P	361454	913708	29498	35308 p	14382	13716
4	14.00	X	IU	NC40	5 1/4	2 11/16	15.29	15319 P	361454	776406	29498	25531 p	14382	13716
4	14.00	X	EU	NC46	6	3 1/4	16.21	19937 P	361454	901164	29498	33228 p	14382	13716
4	14.00	SS95	EU	NC46	6	3	16.08	21448 P	361454	961058	29498	35747 p	14382	13716
4	14.00	G	IU	4 H90	5 1/2	2 13/16	15.63	21185 P	399502	913708	32603	35308 p	15896	15159
4	14.00	G	IU	NC40	5 1/2	2 7/16	15.87	17858 P	399502	897161	32603	29764 p	15896	15159
4	14.00	G	EU	NC46	6	3 1/4	16.21	19937 P	399502	901164	32603	33228 p	15896	15159
4	14.00	S	IU	4 H90	5 1/2	2 13/16	15.63	21180 P	513646	913708	41918	35308 p	20141	19491
4	14.00	S	IU	NC40	5 1/2	2	16.14	21758 P	513646	1080135	41918	36262 p	20141	19491
4	14.00	S	EU	NC46	6	3	16.44	23399 P	513646	1048426	41918	38998 p	20141	19491
4	14.00	V	EU	NC46	6	3	16.08	23398 P	570720	1048427	46604	38997 p	21915	21656
4	15.70	E	IU	4 H90	5 1/2	2 13/16	17.09	21185 P	324118	913708	25810	35308 p	12896	12469
4	15.70	E	IU	NC40	5 1/4	2 11/16	16.80	15319 P	324118	776406	25810	25531 p	12896	12469
4	15.70	E	EU	NC46	6	3 1/4	17.54	19937 P	324118	901164	25810	33228 p	12896	12469
4	15.70	X	IU	4 H90	5 1/2	2 13/16	17.23	21185 P	410550	913708	32692	35308 p	16335	15794
4	15.70	X	IU	NC40	5 1/2	2 7/16	17.52	17858 P	410550	897161	32692	29764 p	16335	15794
4	15.70	X	EU	NC46	6	3	18.03	23399 P	410550	1048427	32692	38997 p	16335	15794
4	15.70	X	EU	NC46	6	3 1/4	17.80	19937 P	410550	901164	32692	33228 p	16335	15794
4	15.70	G	IU	4 H90	5 1/2	2 13/16	17.23	21185 P	453765	913708	36134	35308 p	18055	17456
4	15.70	G	IU	NC40	5 1/2	2 7/16	17.52	17859 P	453765	897161	36134	29764 p	18055	17456
4	15.70	G	EU	NC46	6	3	18.03	23399 P	453765	1048427	36134	38997 p	18055	17456

Label 1	**Label 2**	**Grade**	**Up-set Ttype**	**RSC Type** [a]	**New Drill Pipe**									
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
4	15.70	G	EU	NC46	6	3 1/4	17.80	19937 P	453765	901164	36134	33228 p	18055	17456
4	15.70	S	IU	NC46	6	2 5/8	18.23	26982 B	583413	1247230	46458	44978 b	23213	22444
4	15.70	S	EU	NC46	6	2 7/8	18.13	25038 P	583413	1117640	46458	41729 p	23213	22444
4	15.70	S	EU	NC46	6	3	18.02	23398 P	583413	1048426	46458	38998 p	23213	22444
4 1/2	13.75	E	IU	4 1/2 H90	6	3 1/4	15.23	23120 P	270034	938403	25907	38544 p	7173	7904
4 1/2	13.75	E	EU	4 1/2 OH SW	5 3/4	3 31/32	14.04	12407 P	270034	554844	25907	20678 p	7173	7904
4 1/2	13.75	E	EU	4 1/2 WO	6 1/8	3 7/8	14.77	19290 P	270034	848619	25907	33492 p	7173	7904
4 1/2	13.75	E	IU	NC46	6	3 3/8	15.12	18117 P	270034	823115	25907	30195 p	7173	7904
4 1/2	13.75	E	EU	NC50	6 5/8	3 3/4	15.90	22362 P	270034	939096	25907	37269 p	7173	7904
4 1/2	16.60	E	IEU	4 1/2 FH	6	3	18.14	20620 P	330558	976156	30807	34367 p	10392	9829
4 1/2	16.60	E	IEU	4 1/2 H90	6	3 1/4	17.92	23126 P	330558	938403	30807	38544 p	10392	9829
4 1/2	16.60	E	EU	4 1/2 OH SW	5 7/8	3 3/4	17.07	16162 P	330558	713979	30807	26936 p	10392	9829
4 1/2	16.60	E	IEU	NC38 *	5	2 11/16	16.79	10842 P	330558	587308	30807	18071 P	10392	9829
4 1/2	16.60	E	IEU	NC46	6 1/4	3 1/4	18.39	19937 P	330558	901164	30807	33228 p	10392	9829
4 1/2	16.60	E	EU	NC50	6 5/8	3 3/4	18.49	22361 P	330558	939096	30807	37269 p	10392	9829
4 1/2	16.60	SS75	IEU	NC46	6 1/4	3 1/4	18.61	18275 P	330558	826067	30807	30459 p	10392	9829
4 1/2	16.60	SS75	EU	NC50	6 5/8	3 3/4	18.48	20499 P	330558	860838	30807	34164 p	10392	9829
4 1/2	16.60	X	IEU	4 1/2 FH	6	2 3/4	18.70	23695 P	418707	1111637	39022	39491 p	12765	12450
4 1/2	16.60	X	IEU	4 1/2 FH	6	3	18.33	20620 P	418707	976156	39022	34367 p	12765	12450
4 1/2	16.60	X	IEU	4 1/2 H90	6	3	18.47	26969 P	418707	1085391	39022	44938 p	12765	12450
4 1/2	16.60	X	IEU	4 1/2 H90	6	3 1/4	18.11	23120 P	418707	938403	39022	38544 p	12765	12450
4 1/2	16.60	X	IEU	NC46	6 1/4	3	18.63	19937 B	418707	1048426	39022	38998 p	12765	12450
4 1/2	16.60	X	EU	NC50	6 5/8	3 3/4	18.86	22361 P	418707	939095	39022	37269 p	12765	12450
4 1/2	16.60	SS95	IEU	NC46	6 1/4	2 3/4	18.97	24397 P	418707	1085249	39022	40661 p	12765	12450

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe										
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
4 1/2	16.60	SS95	EU	NC50	6 5/8	3 1/2	18.70	24452 P	418707	1017426	39022	40753 p	12765	12450
4 1/2	16.60	G	IEU	4 1/2 FH	6	2 3/4	18.70	23695 P	462781	1111637	43130	39491 p	13825	13761
4 1/2	16.60	G	IEU	4 1/2 FH	6	3	18.33	23695 P	462781	976156	43130	34367 p	13825	13761
4 1/2	16.60	G	IEU	4 1/2 H90	6	3	18.33	26969 P	462781	1085665	43130	44948 p	13825	13761
4 1/2	16.60	G	IEU	NC46	6 1/4	3	18.63	23399 P	462781	1048426	43130	38998 p	13825	13761
4 1/2	16.60	G	EU	NC50	6 5/8	3 3/4	18.86	22361 P	462781	939095	43130	37269 p	13825	13761
4 1/2	16.60	SS105	IEU	NC46	6 1/4	2 3/4	18.97	24397 P	462781	1085249	43130	40661 p	13825	13761
4 1/2	16.60	S	IEU	4 1/2 FH	6 1/4	2 1/2	19.19	26528 P	595004	1235337	55453	44214 p	16773	17693
4 1/2	16.60	S	IEU	4 1/2 H90	6	3	18.33	26963 P	595004	1085665	55453	44948 p	16773	17693
4 1/2	16.60	S	IEU	NC46	6 1/4	2 3/4	18.84	26615 P	595004	1183908	55453	44359 p	16773	17693
4 1/2	16.60	S	EU	NC50	6 5/8	3 1/2	19.13	26674 P	595004	1109920	55453	44456 p	16773	17693
4 1/2	16.60	V	IEU	NC46 *	6 1/4	2 3/4	18.97	26615 P	661110	1183908	61651	44358 P	18106	19658
4 1/2	16.60	V	EU	NC50 *	6 5/8	3 1/2	18.70	26675 P	661110	1109920	61651	44458 P	18106	19658
4 1/2	20.00	E	IEU	4 1/2 FH	6	3	21.64	20620 P	412358	976156	36901	34367 p	12964	12542
4 1/2	20.00	E	IEU	4 1/2 H90	6	3	21.64	26969 P	412358	1085665	36901	44948 p	12964	12542
4 1/2	20.00	E	IEU	NC46	6 1/4	3	22.14	23399 P	412358	1048426	36901	38998 p	12964	12542
4 1/2	20.00	E	EU	NC50	6 5/8	3 5/8	22.13	24549 P	412358	1025980	36901	40915 p	12964	12542
4 1/2	20.00	SS75	IEU	NC46	6 1/4	3	18.61	21448 P	412358	961058	36901	35747 p	12964	12542
4 1/2	20.00	SS75	EU	NC50	6 5/8	3 5/8	22.16	22504 P	412358	940482	36901	37507 p	12964	12542
4 1/2	20.00	X	IEU	4 1/2 FH	6	2 1/2	22.39	26528 P	522320	1235337	46741	44214 p	16421	15886
4 1/2	20.00	X	IEU	4 1/2 H90	6	3	21.91	26969 P	522320	1085391	46741	44938 p	16421	15886
4 1/2	20.00	X	IEU	4 1/2 H90	6	3 1/4	21.78	23120 P	522320	938403	46741	38544 p	16421	15886
4 1/2	20.00	X	IEU	NC46	6 1/4	2 3/4	22.64	26615 P	522320	1183908	46741	44359 p	16421	15886
4 1/2	20.00	X	EU	NC50	6 5/8	3 1/2	22.60	26674 P	522320	1109920	46741	44456 p	16421	15886

					New Drill Pipe									
Label 1	**Label 2**	**Grade**	**Up-set Ttype**	**RSC Type** [a]	**Box OD** (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
4 1/2	20.00	SS95	IEU	NC46	6 1/4	2 1/4	22.59	29589 P	522320	1301233	46741	49315 p	16421	15886
4 1/2	20.00	SS95	EU	NC50	6 5/8	3	22.66	31645 P	522320	1298206	46741	52741 p	16421	15886
4 1/2	20.00	G	IEU	4 1/2 FH	6	2 1/2	22.39	26528 P	577301	1235337	51661	44214 p	18149	17558
4 1/2	20.00	G	IEU	4 1/2 H90	6	3	22.00	26963 P	577301	1085665	51661	44948 p	18149	17558
4 1/2	20.00	G	IEU	NC46	6 1/4	2 1/2	22.83	29578 P	577301	1307608	51661	49297 p	18149	17558
4 1/2	20.00	G	EU	NC50	6 5/8	3 1/2	22.60	26674 P	577301	1109920	51661	44456 p	18149	17558
4 1/2	20.00	SS105	IEU	NC46	6 1/4	2 1/4	22.59	29589 P	577301	1301233	51661	49315 p	18149	17558
4 1/2	20.00	S	IEU	NC46	6 1/4	2 1/4	23.00	32279 P	742244	1419527	66421	53800 p	23335	22575
4 1/2	20.00	S	EU	NC50	6 5/8	3	23.07	34520 P	742244	1416225	66421	57534 p	23335	22575
4 1/2	20.00	V	IEU	NC46 *	6 1/4	2 1/4	22.59	32279 P	824715	1419527	73846	53799 P	25927	25083
4 1/2	20.00	V	EU	NC50 *	6 5/8	3	22.66	34521 P	824715	1416225	73846	57536 P	25927	25083
4 1/2	22.82	E	IEU	NC46	6 1/4	3	24.56	23398 P	471239	1048426	40912	38998 p	14815	14583
4 1/2	22.82	E	EU	NC50	6 5/8	3 5/8	24.11	24550 P	471239	1025980	40912	40915 p	14815	14583
4 1/2	22.82	X	IEU	4 1/2 FH	6 1/4	2 1/4	25.13	29113 P	596903	1347256	51821	48522 p	18765	18472
4 1/2	22.82	X	IEU	NC46	6 1/4	2 3/4	24.77	26615 P	596903	1183908	51821	44359 p	18765	18472
4 1/2	22.82	X	EU	NC50	6 5/8	3 1/2	24.24	26675 P	596903	1109920	51821	44456 p	18765	18472
4 1/2	22.82	G	IEU	NC46	6 1/4	2 1/2	24.96	29578 P	659734	1307608	57276	49297 p	20741	20417
4 1/2	22.82	G	EU	NC50	6 5/8	3 1/4	24.72	30731 P	659734	1268963	57276	51217 p	20741	20417
4 1/2	22.82	S	EU	NC50	6 5/8	2 3/4	25.41	38037 P	848230	1551706	73641	63393 p	26667	26250
5	19.50	E	IEU	5 1/2 FH	7	3 3/4	22.32	37749 B	395595	1448407	41167	62903 b	9962	9503
5	19.50	E	IEU	NC50	6 5/8	3 3/4	21.37	22361 P	395595	939095	41167	37269 p	9962	9503
5	19.50	X	IEU	5 1/2 FH	7	3 3/4	22.58	37749 B	501087	1448407	52144	62903 b	12026	12037
5	19.50	X	IEU	5 H90	6 1/2	3 1/4	21.93	30732 P	501087	1176265	52144	51220 p	12026	12037
5	19.50	X	IEU	NC50	6 5/8	3 1/2	21.89	26674 P	501087	1109920	52144	44456 p	12026	12037

Label 1	**Label 2**	**Grade**	**Up-set Ttype**	**RSC Type** [a]	**New Drill Pipe**									
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
5	19.50	G	IEU	5 1/2 FH	7	3 3/4	22.58	37749 B	553833	1448407	57633	62903 b	12999	13304
5	19.50	G	IEU	5 H90	6 1/2	3	22.15	34805 P	553833	1323527	57633	58008 p	12999	13304
5	19.50	G	IEU	NC50	6 5/8	3 1/4	22.14	30730 P	553833	1268963	57633	51217 p	12999	13304
5	19.50	S	IEU	5 1/2 FH	7 1/4	3 1/2	23.44	43328 P	712070	1619231	74100	72213 p	15672	17105
5	19.50	S	IEU	NC50	6 5/8	2 3/4	22.58	38036 P	712070	1551706	74100	63393 p	15672	17105
5	25.60	E	IEU	5 1/2 FH	7	3 1/2	28.32	37742 B	530144	1619231	52257	62903 b	13500	13125
5	25.60	E	IEU	NC50	6 5/8	3 1/2	27.37	26674 P	530144	1109920	52257	44456 p	13500	13125
5	25.60	SS75	IEU	5 1/2 FH	7	3 1/2	28.29	34603 B	530144	1484295	52257	57672 b	13500	13125
5	25.60	SS75	IEU	NC50 *	6 5/8	3 1/2	27.36	24452 P	530144	1017426	52257	40753 P	13500	13125
5	25.60	X	IEU	5 1/2 FH	7	3 1/2	28.56	37742 B	671515	1619231	66192	62903 b	17100	16625
5	25.60	X	IEU	NC50	6 5/8	3	28.09	34520 P	671515	1416225	66192	57534 b	17100	16625
5	25.60	SS95	IEU	5 1/2 FH	7 1/4	3 1/4	29.08	43300 B	671515	1630084	66192	72167 b	17100	16625
5	25.60	G	IEU	5 1/2 FH	7 1/4	3 1/2	29.13	43328 P	742201	1619231	73159	72213 p	18900	18375
5	25.60	G	IEU	NC50	6 5/8	2 3/4	28.30	38036 P	742201	1551706	73159	63393 b	18900	18375
5	25.60	S	IEU	5 1/2 FH	7 1/4	3 1/4	29.40	47230 B	954259	1778274	94062	78716 b	24300	23625
5	25.60	V	IEU	5 1/2 FH *	7 1/4	3 1/4	29.08	47237 B	1060290	1778274	104577	78728 B	27000	26250
5	TW 0.750	SS95	IEU	5 1/2 FH	7 1/4	3 1/4	38.44	43300 B	951314	1630084	85247	72167 b	24225	24938
5	TW 0.750	V	IEU	5 1/2 FH *	7 1/4	3 1/4	38.44	47237 B	1502074	1778274	134600	78728 B	38250	39375
5 1/2	21.90	E	IEU	5 1/2 FH	7	4	23.81	33412 P	437116	1265802	50710	55687 p	8413	8615
5 1/2	21.90	SS75	IEU	5 1/2 FH	7	4	24.10	30627 P	437116	1160318	50710	51045 p	8413	8615
5 1/2	21.90	X	IEU	5 1/2 FH	7	3 3/4	24.43	37742 B	553681	1448407	64233	62903 b	10019	10912
5 1/2	21.90	X	IEU	5 1/2 H90	7	3 1/2	24.80	34820 P	553681	1268877	64233	58033 p	10019	10912
5 1/2	21.90	SS95	IEU	5 1/2 FH	7 1/2	3	26.12	47720 P	553681	1765075	64233	79534 p	10019	10912
5 1/2	21.90	G	IEU	5 1/2 FH	7 1/4	3 1/2	25.28	43328 P	611963	1619231	70994	72213 p	10753	12061

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe									
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
5 1/2	21.90	S	IEU	5 1/2 FH	7 1/2	3	26.39	52059 P	786809	1925536	91278	86765 p	12679	15507
5 1/2	21.90	V	IEU	5 1/2 FH	7 1/2	3	26.12	52058 P	874230	1925536	101482	86764 p	13476	17230
5 1/2	24.70	E	IEU	5 1/2 FH	7	4	26.33	33412 P	497222	1265802	56574	55687 p	10464	9903
5 1/2	24.70	SS75	IEU	5 1/2 FH	7	4	26.57	30627 P	497222	1160318	56574	51045 p	10464	9903
5 1/2	24.70	X	IEU	5 1/2 FH	7 1/4	3 1/2	27.77	43328 P	629814	1619231	71660	72213 p	12933	12544
5 1/2	24.70	SS95	IEU	5 1/2 FH	7 1/2	3	28.57	47720 P	629814	1765075	71660	79534 p	12933	12544
5 1/2	24.70	G	IEU	5 1/2 FH	7 1/4	3 1/2	27.77	43328 P	696111	1619231	79204	72213 p	14013	13865
5 1/2	24.70	S	IEU	5 1/2 FH	7 1/2	3	28.87	52059 P	894999	1925536	101833	86765 p	17023	17826
5 1/2	24.70	V	IEU	5 1/2 FH *	7 1/2	3	28.57	52058 P	994440	1925536	113217	86764 P	18389	19807
5 1/2	TW 0.500	V	IEU	5 1/2 FH *	7 1/4	3 1/2	31.11	43327 P	1178097	1619231	130109	72212 P	24793	23864
5 1/2	TW 0.625	V	IEU	5 1/2 FH *	7 1/4	3 1/8	36.67	47237 B	1435806	1853377	151702	78728 B	30217	29830
5 1/2	TW 0.750	V	IEU	5 1/2 FH *	7 1/2	3	42.24	52058 P	1678789	1925536	169802	86764 P	35331	35795
5 7/8	23.40	E	IEU	5 1/2 FH	7	4	25.40	33412 P	469013	1265801	58640	55686 p	7453	8065
5 7/8	23.40	X	IEU	5 1/2 FH	7 1/4	3 1/2	26.44	43327 P	594083	1619231	74278	72212 p	8774	10216
5 7/8	23.40	G	IEU	5 1/2 FH	7 1/4	3 1/2	26.44	43327 P	656619	1619231	82096	72212 p	9362	11291
5 7/8	23.40	S	IEU	5 1/2 FH *	7 1/4	3	26.88	47237 B	844224	1925536	105553	78728 B	10820	14517
5 7/8	23.40	V	IEU	5 1/2 FH *	7 1/4	3	26.88	47237 B	938026	1925536	117281	78728 B	11380	16130
5 7/8	26.30	E	IEU	5 1/2 FH	7	3 1/4	28.80	37749 B	533890	1778274	65548	62915 b	9559	9271
5 7/8	26.30	X	IEU	5 1/2 FH	7 1/4	3 1/2	29.10	43327 P	676261	1619231	83027	72212 p	11502	11744
5 7/8	26.30	G	IEU	5 1/2 FH *	7 1/4	3 1/2	29.10	43327 P	747446	1619231	91767	72212 P	12414	12980
5 7/8	26.30	S	IEU	5 1/2 FH *	7 1/2	3 1/4	29.89	47845 P	961002	1778274	117986	79742 P	14888	16688
5 7/8	26.30	V	IEU	5 1/2 FH *	7 1/2	3 1/4	29.89	47845 P	1067780	1778274	131096	79742 P	15979	18543
5 7/8	TW 0.625	S	IEU	5 1/2 FH *	7 1/2	3	40.13	52058 P	1391627	1925536	159285	86764 P	25668	25133
5 7/8	TW 0.625	V	IEU	5 1/2 FH *	7 1/2	3	40.13	52058 P	1546253	1925536	176983	86764 P	28520	27926

Label 1	Label 2	Grade	Up-set Ttype	RSC Type [a]	New Drill Pipe									
					Box OD (in.)	**Pin ID** (in.)	**Ap-prox. Mass** (lb/ft)	**Make-up Torque** [b,c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** [d] (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. In-ternal Pressure Pipe Body** (psi)
5 7/8	TW 0.750	S	IEU	5 1/2 FH *	7 1/2	3	45.54	52058 P	1630192	1925536	179081	86764 P	30068	30160
5 7/8	TW 0.750	V	IEU	5 1/2 FH *	7 1/2	3	45.54	52058 P	1811325	1925536	198979	86764 P	33409	33511
5 7/8	TW 0.813	S	IEU	5 1/2 FH *	7 1/2	3	48.51	52058 P	1745405	1925536	187854	86764 P	32193	32693
5 7/8	TW 0.813	V	IEU	5 1/2 FH *	7 1/2	3	48.51	52058 P	1939339	1925536	208727	86764 P	35770	36326
6 5/8	25.20	E	IEU	6 5/8 FH	8	5	27.57	43934 P	489464	1447697	70580	73224 p	4788	6538
6 5/8	25.20	X	IEU	6 5/8 FH	8	5	27.57	43934 P	619988	1448416	89402	73224 p	5321	8281
6 5/8	25.20	G	IEU	6 5/8 FH	8 1/4	4 3/4	28.63	51280 P	685250	1678145	98812	85467 p	5500	9153
6 5/8	25.20	S	IEU	6 5/8 FH	8 1/2	4 1/4	30.06	65012 P	881035	2102260	127044	108353 p	6036	11768
6 5/8	25.20	V	IEU	6 5/8 FH *	8 1/2	4 1/4	29.74	65012 P	978930	2102260	141246	108354 P	6253	13075
6 5/8	27.70	E	IEU	6 5/8 FH	8	5	29.43	43934 P	534199	1447697	76295	73224 p	5894	7172
6 5/8	27.70	X	IEU	6 5/8 FH	8 1/4	4 3/4	30.48	51280 P	676651	1678145	96640	85467 p	6755	9084
6 5/8	27.70	G	IEU	6 5/8 FH	8 1/4	4 3/4	30.48	51280 P	747877	1678145	106813	85467 p	7103	10040
6 5/8	27.70	S	IEU	6 5/8 FH	8 1/2	4 1/4	31.91	65012 P	961556	2102260	137330	108353 P	7813	12909
6 5/8	27.70	V	IEU	6 5/8 FH *	8 1/2	4 1/4	31.56	65012 P	1068405	2102260	152682	108354 P	7975	14343
6 5/8	TW 0.522	V	IEU	6 5/8 FH *	8 1/2	4 1/4	38.53	65012 P	1501257	2102260	204526	108354 P	20060	20683
6 5/8	TW 0.625	V	IEU	6 5/8 FH *	8 1/2	4 1/4	45.17	65012 P	1767146	2102260	233509	108354 P	25632	24764
6 5/8	TW 0.750	V	IEU	6 5/8 FH *	8 1/2	4 1/4	52.39	65012 P	2076396	2102260	264478	108354 P	30117	29717

[a] Tool joints marked with an asterisk (*), the dimensions shown has lower torsional yield ratio than the 0.80 which is generally used.
[b] P = Pin limit, B = Box limit
[c] Normal torque range is tabulated value plus 10 %; higher torque values may be used under extreme conditions.
[d] p = pin limited yield; b = box limited yield; P or B indicated that tool joint could not meet 80 % of tube torsional yield.

NOTE All calculated values are based on the equations provided in Annex G.

Table A.3—Premium Used Drill Pipe Properties

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
2 3/8	4.85	E	2 3/8 OH LW	3 1/8	2 5/32	5/32	1862	76893	145057	3725	3103	8522	9600
2 3/8	4.85	E	2 3/8 SL H90	3 3/32	2 3/16	5/32	1877	76893	128485	3725	3129	8522	9600
2 3/8	4.85	E	2 3/8 WO	3 3/16	2 1/8	5/32	1872	76893	147545	3725	3120	8522	9600
2 3/8	4.85	E	NC26	3 1/4	2 3/16	5/32	1946	76893	151324	3725	3243	8522	9600
2 3/8	6.65	E	2 3/8 OH LW	3 1/8	2 1/16	5/32	2377	107616	182332	4811	3961	13378	14147
2 3/8	6.65	E	2 3/8 PAC	2 25/32	1 1/2	5/32	2382	107616	204634	4811	3969	13378	14147
2 3/8	6.65	E	2 3/8 SL H90	3 3/32	2 3/32	5/32	2468	107616	166313	4811	4113	13378	14147
2 3/8	6.65	E	NC26	3 1/4	2 3/32	5/32	2478	107616	189152	4811	4129	13378	14147
2 3/8	6.65	X	2 3/8 SL H90	3 3/32	2	5/32	3037	136313	202484	6093	5062	16945	17920
2 3/8	6.65	X	NC26	3 1/4	2	5/32	2990	136313	225324	6093	4984	16945	17920
2 3/8	6.65	G	2 3/8 SL H90	3 1/8	1 15/16	5/32	3404	150662	225678	6735	5673	18729	19806
2 3/8	6.65	G	NC26	3 9/32	1 15/16	5/32	3276	150662	248517	6735	5460	18729	19806
2 7/8	6.85	E	2 7/8 OH LW	3 17/32	2 15/32	5/32	3071	106946	209309	6332	5118	7640	9057
2 7/8	6.85	E	2 7/8 SL H90	3 9/16	2 19/32	5/32	3162	106946	186470	6332	5270	7640	9057
2 7/8	6.85	E	2 7/8 WO	3 11/16	2 9/16	5/32	3259	106946	218648	6332	5431	7640	9057
2 7/8	6.85	E	NC31	3 25/32	2 21/32	5/32	3118	106946	207737	6332	5197	7640	9057
2 7/8	10.40	E	2 7/8 OH SW	3 19/32	2 9/32	5/32	4274	166535	293248	8858	7124	14223	15110
2 7/8	10.40	E	2 7/8 PAC	3 5/32	1 1/4	1/4	4284	166535	337819	8858	7140	14223	15110
2 7/8	10.40	E	2 7/8 SL H90	3 9/16	2 7/16	5/32	4149	166535	260561	8858	6915	14223	15110
2 7/8	10.40	E	2 7/8 XH	3 23/32	2 13/32	5/32	4359	166535	290695	8858	7265	14223	15110
2 7/8	10.40	E	NC26	3 13/32	1 3/4	3/16	4260	166535	313681	8858	7100	14223	15110
2 7/8	10.40	E	NC31	3 13/16	2 1/2	5/32	4357	166535	283669	8858	7261	14223	15110

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
2 7/8	10.40	X	2 7/8 SL H90	3 11/16	2 5/16	3/16	5516	210945	316521	11220	9193	18016	19139
2 7/8	10.40	X	NC31	3 29/32	2 11/32	3/16	5534	210945	354999	11220	9224	18016	19139
2 7/8	10.40	G	2 7/8 SL H90	3 23/32	2 1/4	13/64	6008	233149	343396	12401	10013	19912	21153
2 7/8	10.40	G	NC31	3 15/16	2 9/32	13/64	5987	233149	382242	12401	9979	19912	21153
2 7/8	10.40	S	2 7/8 SL H90	3 27/32	2	17/64	7749	299764	443534	15945	12915	25602	27197
2 7/8	10.40	S	NC31	4 1/16	2 1/32	17/64	7694	299764	483853	15945	12823	25602	27197
3 1/2	9.50	E	3 1/2 OH LW	4 9/32	3 5/32	5/32	5342	152979	301413	11094	8903	7074	8709
3 1/2	9.50	E	3 1/2 SL H90	4 3/16	3 5/32	5/32	5519	152979	275517	11094	9198	7074	8709
3 1/2	9.50	E	3 1/2 WO	4 13/32	3 3/16	5/32	5536	152979	310455	11094	9227	7074	8709
3 1/2	9.50	E	NC38	4 13/32	3 3/16	5/32	5508	152979	310455	11094	9180	7074	8709
3 1/2	9.50	SS75	NC38	4 7/16	3 5/32	5/32	5374	152979	301711	11094	8956	7074	8709
3 1/2	13.30	E	3 1/2 H90	4 17/32	3 9/32	5/32	7054	212150	360932	14361	11757	12015	12617
3 1/2	13.30	E	3 1/2 OH SW	4 13/32	3	3/16	7082	212150	392071	14361	11803	12015	12617
3 1/2	13.30	E	3 1/2 XH	4 11/32	2 25/32	3/16	6971	212150	401864	14361	11619	12015	12617
3 1/2	13.30	E	NC31	4	2 1/8	15/64	6895	212150	447130	14361	11491	12015	12617
3 1/2	13.30	E	NC38	4 1/2	3 1/16	11/64	6910	212150	384086	14361	11517	12015	12617
3 1/2	13.30	SS75	NC38	4 17/32	3	3/16	6962	212150	384814	14361	11603	12015	12617
3 1/2	13.30	X	3 1/2 H90	4 21/32	3 5/32	3/16	9033	268723	436772	18191	15055	15218	15982
3 1/2	13.30	X	3 1/2 SL H90	4 3/8	2 7/8	13/64	8738	268723	435388	18191	14564	15218	15982
3 1/2	13.30	X	NC38	4 19/32	2 7/8	7/32	8824	268723	489010	18191	14706	15218	15982
3 1/2	13.30	SS95	NC38	4 21/32	2 13/16	1/4	8781	268723	478970	18191	14634	15218	15982
3 1/2	13.30	G	3 1/2 SL H90	4 7/16	2 13/16	15/64	9661	297010	468890	20106	16102	16820	17664
3 1/2	13.30	G	NC38	4 21/32	2 25/32	1/4	9881	297010	538988	20106	16468	16820	17664
3 1/2	13.30	S	3 1/2 SL H90	4 19/32	2 17/32	5/16	12736	381870	610538	25850	21227	21626	22711

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
3 1/2	13.30	S	NC38	4 13/16	2 1/2	21/64	12616	381870	678979	25850	21026	21626	22711
3 1/2	13.30	S	NC40	5	2 15/16	9/32	12564	381870	643871	25850	20940	21626	22711
3 1/2	13.30	V	NC38	4 29/32	2 11/32	3/8	14060	424300	750309	28740	23433	24029	25234
3 1/2	15.50	E	NC38	4 17/32	2 31/32	3/16	7787	250620	437377	16146	12978	14472	15394
3 1/2	15.50	SS75	NC38	4 19/32	2 29/32	7/32	7883	250620	432651	16146	13139	14472	15394
3 1/2	15.50	X	NC38	4 21/32	2 25/32	1/4	9881	317452	538988	20452	16468	18331	19499
3 1/2	15.50	SS95	NC40	4 29/32	3 3/32	15/64	9842	317452	508799	20452	16404	18331	19499
3 1/2	15.50	G	NC38	4 23/32	2 21/32	9/32	10959	350868	603047	22605	18265	20260	21552
3 1/2	15.50	G	NC40	4 15/16	3 1/16	1/4	11109	350868	573185	22605	18515	20260	21552
3 1/2	15.50	S	NC38	4 29/32	2 11/32	3/8	14060	451115	750309	29063	23433	26049	27710
3 1/2	15.50	S	NC40	5 3/32	2 13/16	21/64	13968	451115	711611	29063	23280	26049	27710
3 1/2	15.50	V	NC40	5 5/32	2 21/32	23/64	15649	501239	792145	32312	26081	28943	30789
4	11.85	E	4 H90	4 7/8	3 23/32	5/32	7621	182016	355607	15310	12701	5704	7860
4	11.85	E	4 OH LW	5	3 27/32	5/32	7493	182016	362912	15310	12489	5704	7860
4	11.85	E	4 WO	5 7/32	4	5/32	7513	182016	358373	15310	12522	5704	7860
4	11.85	E	NC46	5 7/32	4 1/32	5/32	7659	182016	365038	15310	12765	5704	7860
4	14.00	E	4 H90	4 15/16	3 5/8	5/32	8976	224182	420495	18196	14960	9012	9900
4	14.00	E	4 OH SW	5 1/16	3 3/4	5/32	8928	224182	430008	18196	14881	9012	9900
4	14.00	E	4 SH	4 7/16	2 19/32	15/64	8732	224182	496848	18196	14554	9012	9900
4	14.00	E	NC40	4 13/16	3 1/4	3/16	8833	224182	461634	18196	14721	9012	9900
4	14.00	E	NC46	5 9/32	3 15/16	5/32	9237	224182	435448	18196	15396	9012	9900
4	14.00	SS75	NC46	5 5/16	3 29/32	5/32	8949	224182	420337	18196	14914	9012	9900
4	14.00	X	4 H90	5 1/16	3 1/2	13/64	11320	283963	504434	23048	18867	10795	12540
4	14.00	X	NC40	4 15/16	3 1/16	1/4	11109	283963	573185	23048	18515	10795	12540

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4	14.00	X	NC46	5 3/8	3 13/16	3/16	11306	283963	526750	23048	18844	10795	12540
4	14.00	SS95	NC46	5 13/32	3 3/4	13/64	11082	283963	523689	23048	18471	10795	12540
4	14.00	G	4 H90	5 3/32	3 13/32	7/32	12471	313854	565456	25474	20786	11622	13860
4	14.00	G	NC40	5	2 15/16	9/32	12564	313854	643871	25474	20940	11622	13860
4	14.00	G	NC46	5 7/16	3 3/4	7/32	12320	313854	571297	25474	20533	11622	13860
4	14.00	S	4 H90	5 1/4	3 3/16	19/64	16029	403527	701397	32752	26714	13836	17820
4	14.00	S	NC40	5 3/16	2 5/8	3/8	15975	403527	807700	32752	26624	13836	17820
4	14.00	S	NC46	5 9/16	3 17/32	9/32	15762	403527	721413	32752	26270	13836	17820
4	14.00	V	NC46	5 21/32	3 13/32	21/64	17653	448363	803143	36414	29422	14785	19800
4	15.70	E	4 H90	5	3 19/32	11/64	9838	253851	441756	20067	16397	10914	11400
4	15.70	E	NC40	4 7/8	3 5/32	7/32	9985	253851	518237	20067	16641	10914	11400
4	15.70	E	NC46	5 5/16	3 29/32	5/32	9762	253851	458550	20067	16270	10914	11400
4	15.70	X	4 H90	5 3/32	3 13/32	7/32	12471	321544	565456	25418	20786	13825	14440
4	15.70	X	NC40	5	2 31/32	9/32	12205	321544	626475	25418	20342	13825	14440
4	15.70	X	NC46	5 7/16	3 3/4	7/32	12320	321544	571297	25418	20533	13825	14440
4	15.70	G	4 H90	5 5/32	3 11/32	1/4	13720	355391	605217	28094	22867	15190	15960
4	15.70	G	NC40	5 1/16	2 27/32	5/16	13622	355391	694952	28094	22703	15190	15960
4	15.70	G	NC46	5 15/32	3 21/32	15/64	13552	355391	636737	28094	22587	15190	15960
4	15.70	S	NC46	5 21/32	3 13/32	21/64	17653	456931	803143	36120	29422	18593	20520
4	15.70	S	NC46	5 21/32	3 13/32	21/64	17653	456931	803143	36120	29422	18593	20520
4 1/2	13.75	E	4 1/2 H90	5 1/4	4	5/32	9857	213258	425657	20403	16428	4686	7227
4 1/2	13.75	E	4 1/2 OH SW	5 3/8	4 3/32	11/64	10188	213258	459860	20403	16979	4686	7227
4 1/2	13.75	E	4 1/2 WO	5 21/32	4 11/32	5/32	9950	213258	453032	20403	16583	4686	7227
4 1/2	13.75	E	NC46	5 5/16	3 7/8	5/32	9941	213258	481467	20403	16569	4686	7227

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4 1/2	13.75	E	NC50	5 21/32	4 13/32	5/32	9910	213258	434631	20403	16516	4686	7227
4 1/2	16.60	E	4 1/2 FH	5 11/32	3 21/32	3/16	11434	260165	564466	24139	19057	7525	8987
4 1/2	16.60	E	4 1/2 H90	5 11/32	3 29/32	11/64	11799	260165	495514	24139	19665	7525	8987
4 1/2	16.60	E	4 1/2 OH SW	5 7/16	4	13/64	11857	260165	531374	24139	19761	7525	8987
4 1/2	16.60	E	NC38	4 25/32	2 19/32	5/16	11758	260165	633972	24139	19597	7525	8987
4 1/2	16.60	E	NC46	5 13/32	3 25/32	13/64	11815	260165	549116	24139	19691	7525	8987
4 1/2	16.60	E	NC50	5 3/4	4 5/16	11/64	11783	260165	511667	24139	19638	7525	8987
4 1/2	16.60	SS75	NC46	5 7/16	3 23/32	7/32	11750	260165	543853	24139	19583	7525	8987
4 1/2	16.60	SS75	NC50	5 25/32	4 1/4	3/16	11930	260165	515262	24139	19884	7525	8987
4 1/2	16.60	X	4 1/2 FH	5 1/2	3 7/16	17/64	14689	329542	710716	30576	24482	8868	11383
4 1/2	16.60	X	4 1/2 H90	5 15/32	3 23/32	15/64	15208	329542	630259	30576	25346	8868	11383
4 1/2	16.60	X	NC46	5 17/32	3 19/32	17/64	14795	329542	679443	30576	24659	8868	11383
4 1/2	16.60	X	NC50	5 27/32	4 5/32	7/32	14837	329542	636380	30576	24729	8868	11383
4 1/2	16.60	SS95	NC46	5 19/32	3 1/2	19/64	14887	329542	680278	30576	24811	8868	11383
4 1/2	16.60	SS95	NC50	5 29/32	4 3/32	1/4	14699	329542	627895	30576	24498	8868	11383
4 1/2	16.60	G	4 1/2 FH	5 9/16	3 5/16	19/64	16391	364231	790237	33795	27318	9467	12581
4 1/2	16.60	G	4 1/2 H90	5 17/32	3 5/8	17/64	16861	364231	695147	33795	28102	9467	12581
4 1/2	16.60	G	NC46	5 19/32	3 1/2	19/64	16240	364231	742121	33795	27067	9467	12581
4 1/2	16.60	G	NC50	5 29/32	4 1/16	1/4	16622	364231	708998	33795	27703	9467	12581
4 1/2	16.60	SS105	NC46	5 21/32	3 3/8	21/64	16580	364231	754522	33795	27634	9467	12581
4 1/2	16.60	S	4 1/2 FH	5 3/4	2 31/32	25/64	20873	468297	993735	43450	34789	10964	16176
4 1/2	16.60	S	4 1/2 H90	5 11/16	3 3/8	11/32	21098	468297	860080	43450	35164	10964	16176
4 1/2	16.60	S	NC46	5 25/32	3 5/32	25/64	21235	468297	957768	43450	35392	10964	16176
4 1/2	16.60	S	NC50	6 1/16	3 13/16	21/64	21006	468297	894549	43450	35010	10964	16176

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4 1/2	16.60	V	NC46	5 7/8	3	7/16	23398	520330	1048427	48308	38997	11537	17973
4 1/2	16.60	V	NC50	6 5/32	3 11/16	3/8	23464	520330	982906	48308	39106	11537	17973
4 1/2	20.00	E	4 1/2 FH	5 7/16	3 1/2	15/64	13523	322916	669850	28683	22538	10975	11467
4 1/2	20.00	E	4 1/2 H90	5 7/16	3 25/32	7/32	14086	322916	586081	28683	23477	10975	11467
4 1/2	20.00	E	NC46	5 1/2	3 21/32	1/4	13815	322916	636737	28683	23025	10975	11467
4 1/2	20.00	E	NC50	5 13/16	4 3/16	13/64	14071	322916	611805	28683	23451	10975	11467
4 1/2	20.00	SS75	NC46	5 17/32	3 9/16	17/64	13786	322916	642143	28683	22977	10975	11467
4 1/2	20.00	SS75	NC50	5 7/8	4 1/8	15/64	14151	322916	605706	28683	23586	10975	11467
4 1/2	20.00	X	4 1/2 FH	5 5/8	3 1/4	21/64	17314	409026	828894	36332	28857	13901	14524
4 1/2	20.00	X	4 1/2 H90	5 9/16	3 9/16	9/32	17921	409026	737485	36332	29868	13901	14524
4 1/2	20.00	X	NC46	5 21/32	3 13/32	21/64	17653	409026	803143	36332	29422	13901	14524
4 1/2	20.00	X	NC50	5 15/16	4	17/64	17485	409026	756491	36332	29142	13901	14524
4 1/2	20.00	SS95	NC46	5 23/32	3 9/32	23/64	17863	409026	808434	36332	29772	13901	14524
4 1/2	20.00	SS95	NC50	6	3 29/32	19/64	17630	409026	757486	36332	29383	13901	14524
4 1/2	20.00	G	4 1/2 FH	5 11/16	3 3/32	23/64	19355	452082	922313	40157	32258	15350	16053
4 1/2	20.00	G	4 1/2 H90	5 5/8	3 15/32	5/16	19539	452082	799611	40157	32566	15350	16053
4 1/2	20.00	G	NC46	5 23/32	3 9/32	23/64	19487	452082	881928	40157	32478	15350	16053
4 1/2	20.00	G	NC50	6 1/32	3 29/32	5/16	19542	452082	826348	40157	32569	15350	16053
4 1/2	20.00	SS105	NC46	5 25/32	3 5/32	25/64	19466	452082	877954	40157	32443	15350	16053
4 1/2	20.00	S	NC46	5 15/16	2 7/8	15/32	25038	581248	1117640	51630	41729	18806	20640
4 1/2	20.00	S	NC50	6 7/32	3 19/32	13/32	25087	581248	1047241	51630	41812	18806	20640
4 1/2	20.00	V	NC46	6 1/32	2 21/32	33/64	27756	645831	1231676	57402	46260	20405	22933
4 1/2	20.00	V	NC50	6 5/16	3 7/16	29/64	27713	645831	1150785	57402	46189	20405	22933
4 1/2	22.82	E	NC46	5 9/16	3 9/16	9/32	15280	367566	700520	31587	25467	12655	13333

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4 1/2	22.82	E	NC50	5 7/8	4 1/8	15/64	15438	367566	660770	31587	25730	12655	13333
4 1/2	22.82	X	4 1/2 FH	5 11/16	3 3/32	23/64	19355	465584	922313	40010	32258	16030	16889
4 1/2	22.82	X	NC46	5 23/32	3 9/32	23/64	19487	465584	881928	40010	32478	16030	16889
4 1/2	22.82	X	NC50	6	3 29/32	19/64	19232	465584	826348	40010	32054	16030	16889
4 1/2	22.82	G	NC46	5 13/16	3 5/32	13/32	21263	514593	957768	44222	35438	17718	18667
4 1/2	22.82	G	NC50	6 3/32	3 13/16	11/32	21245	514593	894549	44222	35409	17718	18667
4 1/2	22.82	S	NC50	6 9/32	3 7/16	7/16	27425	661620	1150785	56856	45709	22780	24000
5	19.50	E	5 1/2 FH	6 3/8	4 25/32	3/16	15744	311535	619229	32285	26239	7041	8688
5	19.50	E	NC50	5 7/8	4 3/32	15/64	15765	311535	684976	32285	26275	7041	8688
5	19.50	X	5 1/2 FH	6 1/2	4 19/32	1/4	20210	394612	784898	40895	33683	8241	11005
5	19.50	X	5 H90	5 27/32	3 27/32	9/32	19859	394612	779012	40895	33098	8241	11005
5	19.50	X	NC50	6 1/32	3 7/8	5/16	20113	394612	849266	40895	33522	8241	11005
5	19.50	G	5 1/2 FH	6 9/16	4 1/2	9/32	22301	436150	865248	45199	37169	8765	12163
5	19.50	G	5 H90	5 15/16	3 23/32	21/64	22321	436150	868106	45199	37202	8765	12163
5	19.50	G	NC50	6 3/32	3 25/32	11/32	21806	436150	916914	45199	36343	8765	12163
5	19.50	S	5 1/2 FH	6 3/4	4 1/4	3/8	28034	560764	1071415	58113	46723	10029	15638
5	19.50	S	NC50	6 5/16	3 13/32	29/64	28226	560764	1170941	58113	47044	10029	15638
5	25.60	E	5 1/2 FH	6 1/2	4 5/8	1/4	19475	414690	757747	40544	32458	11458	12000
5	25.60	E	NC50	6 1/32	3 29/32	5/16	19542	414690	826348	40544	32569	11458	12000
5	25.60	SS75	5 1/2 FH	6 17/32	4 17/32	17/64	19482	414690	768762	40544	32470	11458	12000
5	25.60	SS75	NC50	6 3/32	3 13/16	11/32	19475	414690	820003	40544	32458	11458	12000
5	25.60	X	5 1/2 FH	6 21/32	4 3/8	21/64	25245	525274	969805	51356	42075	14514	15200
5	25.60	X	NC50	6 7/32	3 19/32	13/32	25087	525274	1047241	51356	41812	14514	15200
5	25.60	SS95	5 1/2 FH	6 23/32	4 9/32	23/64	25064	525274	959098	51356	41774	14514	15200

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
5	25.60	G	5 1/2 FH	6 23/32	4 9/32	23/64	27343	580566	1046289	56762	45571	16042	16800
5	25.60	G	NC50	6 9/32	3 7/16	7/16	27425	580566	1150785	56762	45709	16042	16800
5	25.60	S	5 1/2 FH	6 15/16	3 29/32	15/32	35358	746443	1335659	72979	58929	20510	21600
5	25.60	V	5 1/2 FH	7 1/16	3 23/32	17/32	39130	829380	1470404	81137	65217	22332	24000
5	TW 0.750	SS95	5 1/2 FH	6 29/32	3 31/32	29/64	31226	734190	1181832	64522	52043	21159	22800
5	TW 0.750	V	5 1/2 FH	7 5/16	3 3/16	21/32	48927	1159248	1816194	101877	81545	33409	36000
5 1/2	21.90	E	5 1/2 FH	6 15/32	4 5/8	15/64	19179	344780	757747	39863	31965	5730	7876
5 1/2	21.90	SS75	5 1/2 FH	6 17/32	4 9/16	17/64	19196	344780	744210	39863	31993	5730	7876
5 1/2	21.90	X	5 1/2 FH	6 5/8	4 13/32	5/16	24420	436721	943942	50494	40699	6542	9977
5 1/2	21.90	X	5 1/2 H90	6 7/32	4	11/32	24694	436721	915142	50494	41157	6542	9977
5 1/2	21.90	SS95	5 1/2 FH	6 11/16	4 5/16	11/32	24353	436721	935897	50494	40588	6542	9977
5 1/2	21.90	G	5 1/2 FH	6 23/32	4 9/32	23/64	27343	482692	1046289	55809	45571	6865	11027
5 1/2	21.90	S	5 1/2 FH	6 15/16	3 15/16	15/32	34713	620604	1312557	71754	57855	7496	14177
5 1/2	21.90	V	5 1/2 FH	7 1/32	3 3/4	33/64	38513	689560	1448407	79775	64188	7616	15753
5 1/2	24.70	E	5 1/2 FH	6 9/16	4 17/32	9/32	21668	391285	838649	44320	36113	7635	9055
5 1/2	24.70	SS75	5 1/2 FH	6 19/32	4 7/16	19/64	21410	391285	841403	44320	35684	7635	9055
5 1/2	24.70	X	5 1/2 FH	6 23/32	4 9/32	23/64	27343	495627	1046289	56139	45571	9011	11469
5 1/2	24.70	SS95	5 1/2 FH	6 25/32	4 5/32	25/64	27357	495627	1050217	56139	45594	9011	11469
5 1/2	24.70	G	5 1/2 FH	6 25/32	4 5/32	25/64	29843	547799	1145691	62048	49739	9626	12676
5 1/2	24.70	S	5 1/2 FH	7 1/32	3 3/4	33/64	38513	704313	1448407	79776	64188	11177	16298
5 1/2	24.70	V	5 1/2 FH	7 5/32	3 17/32	37/64	42741	782569	1598522	88694	71236	11778	18109
5 1/2	TW 0.500	V	5 1/2 FH	7 5/16	3 3/16	21/32	48927	923628	1816194	101327	81545	18398	21818
5 1/2	TW 0.625	V	5 1/2 FH	7 1/2	2 23/32	3/4	56425	1119192	2077124	116989	94042	25850	27273
5 1/2	TW 0.750	V	5 1/2 FH	7 5/8	2 9/32	13/16	62393	1300619	2283291	129484	103988	30621	32727

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
5 7/8	23.40	E	5 1/2 FH	6 9/16	4 1/2	9/32	22301	370298	865248	46162	37169	4922	7374
5 7/8	23.40	X	5 1/2 FH	6 3/4	4 7/32	3/8	28721	469044	1096358	58472	47868	5494	9340
5 7/8	23.40	G	5 1/2 FH	6 27/32	4 3/32	27/64	31427	518417	1194287	64627	52378	5693	10323
5 7/8	23.40	S	5 1/2 FH	7 1/16	3 21/32	17/32	40075	666536	1513846	83092	66792	6209	13273
5 7/8	23.40	V	5 1/2 FH	7 3/16	3 7/16	19/32	44485	740595	1660096	92324	74141	6444	14747
5 7/8	26.30	E	5 1/2 FH	6 21/32	4 3/8	21/64	25245	420619	969805	51439	42075	6699	8477
5 7/8	26.30	X	5 1/2 FH	6 27/32	4 3/32	27/64	31427	532785	1194287	65156	52378	7796	10737
5 7/8	26.30	G	5 1/2 FH	6 15/16	3 15/16	15/32	34713	588867	1312557	72014	57855	8269	11867
5 7/8	26.30	S	5 1/2 FH	7 3/16	3 7/16	19/32	44485	757115	1660096	92590	74141	9363	15258
5 7/8	26.30	V	5 1/2 FH	7 5/16	3 5/32	21/32	49461	841239	1834878	102877	82435	9732	16953
5 7/8	TW 0.625	S	5 1/2 FH	7 9/16	2 1/2	25/32	59542	1086795	2184717	123241	99237	21867	22979
5 7/8	TW 0.625	V	5 1/2 FH	7 23/32	2	55/64	65729	1207550	2396775	136934	109548	24296	25532
5 7/8	TW 0.750	S	5 1/2 FH	7 23/32	1 31/32	55/64	66071	1265983	2408464	137173	110119	25931	27574
5 7/8	TW 0.750	V	5 1/2 FH	7 29/32	1 1/8	61/64	73321	1406648	2654484	152414	122202	28812	30638
5 7/8	TW 0.813	S	5 1/2 FH	7 25/32	1 11/16	57/64	68919	1351472	2505381	143097	114865	27934	29891
5 7/8	TW 0.813	V	5 1/2 FH	7 31/32	7/16	63/64	76326	1501636	2755726	158997	127210	31038	33212
6 5/8	25.20	E	6 5/8 FH	7 7/16	5 17/32	1/4	26800	387466	921125	55766	44667	2931	5977
6 5/8	25.20	X	6 5/8 FH	7 5/8	5 5/16	11/32	34327	490790	1144688	71522	57211	3252	7571
6 5/8	25.20	G	6 5/8 FH	7 11/16	5 3/16	3/8	37973	542452	1268388	79050	63288	3353	8368
6 5/8	25.20	S	6 5/8 FH	7 29/32	4 27/32	31/64	48195	697438	1593377	101635	80325	3429	10759
6 5/8	25.20	V	6 5/8 FH	8 1/32	4 21/32	35/64	53954	774932	1761256	111599	89924	3429	11955
6 5/8	27.70	E	6 5/8 FH	7 1/2	5 15/32	9/32	29353	422419	985921	60192	48921	3615	6557
6 5/8	27.70	X	6 5/8 FH	7 11/16	5 7/32	3/8	37258	535064	1237739	77312	62096	4029	8306
6 5/8	27.70	G	6 5/8 FH	7 3/4	5 3/32	13/32	40851	591387	1359230	85450	68085	4222	9180

Label 1	Label 2	Grade	RSC Type	Premium Class Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
6 5/8	27.70	S	6 5/8 FH	8	4 23/32	17/32	52177	760354	1706033	109864	86962	4562	11803
6 5/8	27.70	V	6 5/8 FH	8 1/8	4 1/2	19/32	58310	844836	1896093	120456	97184	4592	13114
6 5/8	TW 0.522	V	6 5/8 FH	8 1/2	3 3/4	25/32	77397	1180461	2479251	160030	128996	13201	18910
6 5/8	TW 0.625	V	6 5/8 FH	8 11/16	3 9/32	7/8	87724	1384264	2789882	181600	146207	19879	22642
6 5/8	TW 0.750	V	6 5/8 FH	8 7/8	2 23/32	31/32	98409	1618706	3107968	204000	164015	25759	27170

[a] Any tool joint with an outside diameter less than the API bevel diameter should be provided with a minimum $^{1}/_{32}$ in. x 45° bevel on the outside and inside diameter of the box shoulder and the outside diameter of the pin shoulder.

[b] In calculation of torsional strengths of tool joints, both new and worn, the bevels of the tool joint shoulders are disregarded; this thickness measurement should be made in the plane of the face from the ID of the counterbore to the outside diameter of the box, disregarding the bevel.

[c] Normal torque range is tabulated value plus 10 %; higher torque values may be used under extreme conditions.

NOTE All calculated values are based on the equations provided in Annex G.

Table A.4—Class 2 Used Drill Pipe Properties

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
2 3/8	4.85	E	2 3/8 OH LW	3 1/8	2 3/16	5/32	1686	66686	132263	3224	2810	6852	8400
2 3/8	4.85	E	2 3/8 SL H90	3 3/32	2 7/32	5/32	1676	66686	115507	3224	2793	6852	8400
2 3/8	4.85	E	2 3/8 WO	3 3/16	2 5/32	5/32	1698	66686	134936	3224	2831	6852	8400
2 3/8	4.85	E	NC26	3 1/4	2 1/4	5/32	1581	66686	125185	3224	2635	6852	8400
2 3/8	6.65	E	2 3/8 OH LW	3 1/8	2 1/8	5/32	2035	92871	157666	4130	3392	12138	12379
2 3/8	6.65	E	2 3/8 PAC	2 23/32	1 19/32	5/32	2045	92871	177298	4130	3408	12138	12379
2 3/8	6.65	E	2 3/8 SL H90	3 3/32	2 5/32	5/32	2076	92871	141278	4130	3461	12138	12379
2 3/8	6.65	E	NC26	3 1/4	2 5/32	5/32	2125	92871	164118	4130	3542	12138	12379
2 3/8	6.65	X	2 3/8 SL H90	3 3/32	2 1/16	5/32	2660	117636	178554	5232	4434	15375	15680
2 3/8	6.65	X	NC26	3 1/4	2 1/16	5/32	2651	117636	201394	5232	4418	15375	15680
2 3/8	6.65	G	2 3/8 SL H90	3 3/32	2 1/32	5/32	2850	130019	190611	5782	4750	16993	17331
2 3/8	6.65	G	NC26	3 1/4	2 1/32	5/32	2822	130019	213451	5782	4703	16993	17331
2 7/8	6.85	E	2 7/8 OH LW	3 17/32	2 1/2	5/32	2843	92801	194675	5484	4738	6055	7925
2 7/8	6.85	E	2 7/8 SL H90	3 17/32	2 5/8	5/32	2887	92801	171099	5484	4812	6055	7925
2 7/8	6.85	E	2 7/8 WO	3 11/16	2 5/8	5/32	2770	92801	188091	5484	4616	6055	7925
2 7/8	6.85	E	NC31	3 25/32	2 11/16	5/32	2864	92801	191998	5484	4773	6055	7925
2 7/8	10.40	E	2 7/8 OH SW	3 9/16	2 3/8	5/32	3728	143557	252107	7591	6213	12938	13221
2 7/8	10.40	E	2 7/8 PAC	3 3/32	1 7/16	7/32	3646	143557	290327	7591	6077	12938	13221
2 7/8	10.40	E	2 7/8 SL H90	3 9/16	2 17/32	5/32	3704	143557	216659	7591	6173	12938	13221
2 7/8	10.40	E	2 7/8 XH	3 11/16	2 1/2	5/32	3667	143557	247345	7591	6111	12938	13221
2 7/8	10.40	E	NC26	3 11/32	1 7/8	5/32	3643	143557	270975	7591	6072	12938	13221
2 7/8	10.40	E	NC31	3 25/32	2 9/16	5/32	3869	143557	253848	7591	6448	12938	13221

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
2 7/8	10.40	X	2 7/8 SL H90	3 5/8	2 13/32	5/32	4756	181839	274827	9615	7927	16388	16746
2 7/8	10.40	X	NC31	3 27/32	2 7/16	5/32	4835	181839	312753	9615	8059	16388	16746
2 7/8	10.40	G	2 7/8 SL H90	3 21/32	2 11/32	11/64	5265	200980	302807	10627	8776	18113	18509
2 7/8	10.40	G	NC31	3 7/8	2 3/8	11/64	5304	200980	341101	10627	8840	18113	18509
2 7/8	10.40	S	2 7/8 SL H90	3 25/32	2 5/32	15/64	6725	258403	382329	13663	11208	23288	23798
2 7/8	10.40	S	NC31	4	2 3/16	15/64	6647	258403	421727	13663	11079	23288	23798
3 1/2	9.50	E	3 1/2 OH LW	4 9/32	3 7/32	5/32	4661	132793	263861	9612	7769	5544	7620
3 1/2	9.50	E	3 1/2 SL H90	4 3/16	3 7/32	5/32	4747	132793	237965	9612	7911	5544	7620
3 1/2	9.50	E	3 1/2 WO	4 13/32	3 1/4	5/32	4815	132793	272535	9612	8026	5544	7620
3 1/2	9.50	E	NC38	4 13/32	3 1/4	5/32	4790	132793	272535	9612	7984	5544	7620
3 1/2	9.50	SS75	NC38	4 13/32	3 7/32	5/32	4721	132793	267288	9612	7869	5544	7620
3 1/2	13.30	E	3 1/2 H90	4 1/2	3 3/8	5/32	6104	183398	302120	12365	10174	10858	11040
3 1/2	13.30	E	3 1/2 OH SW	4 5/16	3 3/32	5/32	5819	183398	338228	12365	9698	10858	11040
3 1/2	13.30	E	3 1/2 XH	4 1/4	2 7/8	5/32	5946	183398	351887	12365	9909	10858	11040
3 1/2	13.30	E	NC31	3 15/16	2 9/32	13/64	5987	183398	382242	12365	9979	10858	11040
3 1/2	13.30	E	NC38	4 7/16	3 1/8	5/32	6214	183398	347639	12365	10357	10858	11040
3 1/2	13.30	SS75	NC38	4 15/32	3 3/32	5/32	6017	183398	335458	12365	10028	10858	11040
3 1/2	13.30	X	3 1/2 H90	4 9/16	3 1/4	5/32	7636	232304	380168	15663	12727	13753	13984
3 1/2	13.30	X	3 1/2 SL H90	4 5/16	2 31/32	11/64	7643	232304	383754	15663	12739	13753	13984
3 1/2	13.30	X	NC38	4 17/32	3	3/16	7594	232304	419797	15663	12657	13753	13984
3 1/2	13.30	SS95	NC38	4 9/16	2 15/16	13/64	7579	232304	416874	15663	12631	13753	13984
3 1/2	13.30	G	3 1/2 SL H90	4 3/8	2 29/32	13/64	8575	256757	418361	17312	14292	15042	15456
3 1/2	13.30	G	NC38	4 19/32	2 29/32	7/32	8600	256757	471983	17312	14333	15042	15456
3 1/2	13.30	S	3 1/2 SL H90	4 1/2	2 23/32	17/64	10717	330116	517763	22258	17862	18396	19872

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
3 1/2	13.30	S	NC38	4 23/32	2 11/16	9/32	10842	330116	587308	22258	18071	18396	19872
3 1/2	13.30	S	NC40	4 29/32	3 3/32	15/64	10737	330116	555053	22258	17895	18396	19872
3 1/2	13.30	V	NC38	4 25/32	2 9/16	5/16	12057	366795	649158	24746	20095	19941	22080
3 1/2	15.50	E	NC38	4 15/32	3 1/16	5/32	6770	215967	384086	13828	11284	13174	13470
3 1/2	15.50	SS75	NC38	4 1/2	3 1/32	11/64	6649	215967	368531	13828	11082	13174	13470
3 1/2	15.50	X	NC38	4 19/32	2 29/32	7/32	8600	273558	471983	17515	14333	16686	17062
3 1/2	15.50	SS95	NC40	4 27/32	3 7/32	13/64	8451	273558	440629	17515	14086	16686	17062
3 1/2	15.50	G	NC38	4 5/8	2 13/16	15/64	9350	302354	522513	19359	15583	18443	18858
3 1/2	15.50	G	NC40	4 27/32	3 3/16	13/64	9591	302354	499554	19359	15986	18443	18858
3 1/2	15.50	S	NC38	4 25/32	2 9/16	5/16	12057	388741	649158	24890	20095	23712	24246
3 1/2	15.50	S	NC40	4 31/32	2 31/32	17/64	11959	388741	626475	24890	19932	23712	24246
3 1/2	15.50	V	NC40	5 1/16	2 27/32	5/16	13622	431934	694952	27672	22703	26347	26940
4	11.85	E	4 H90	4 7/8	3 25/32	5/32	6782	158132	311429	13281	11303	4311	6878
4	11.85	E	4 OH LW	4 31/32	3 29/32	5/32	6502	158132	317260	13281	10836	4311	6878
4	11.85	E	4 WO	5 7/32	4 1/16	5/32	6452	158132	310881	13281	10754	4311	6878
4	11.85	E	NC46	5 7/32	4 3/32	5/32	6590	158132	317178	13281	10983	4311	6878
4	14.00	E	4 H90	4 7/8	3 23/32	5/32	7621	194363	355607	15738	12701	7295	8663
4	14.00	E	4 OH SW	5	3 27/32	5/32	7468	194363	362912	15738	12447	7295	8663
4	14.00	E	4 SH	4 3/8	2 23/32	13/64	7570	194363	434262	15738	12616	7295	8663
4	14.00	E	NC40	4 3/4	3 11/32	5/32	7655	194363	403373	15738	12758	7295	8663
4	14.00	E	NC46	5 7/32	4 1/32	5/32	7659	194363	365038	15738	12765	7295	8663
4	14.00	SS75	NC46	5 1/4	3 31/32	5/32	7828	194363	377815	15738	13046	7295	8663
4	14.00	X	4 H90	4 31/32	3 19/32	5/32	9663	246193	441756	19935	16105	8570	10973
4	14.00	X	NC40	4 27/32	3 3/16	13/64	9591	246193	499554	19935	15986	8570	10973

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe										
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4	14.00	X	NC46	5 5/16	3 29/32	5/32	9762	246193	458550	19935	16270	8570	10973
4	14.00	SS95	NC46	5 11/32	3 27/32	11/64	9764	246193	462184	19935	16273	8570	10973
4	14.00	G	4 H90	5 1/32	3 17/32	3/16	10830	272108	483725	22034	18050	9134	12128
4	14.00	G	NC40	4 29/32	3 3/32	15/64	10737	272108	555053	22034	17895	9134	12128
4	14.00	G	NC46	5 11/32	3 27/32	11/64	10652	272108	504201	22034	17753	9134	12128
4	14.00	S	4 H90	5 5/32	3 11/32	1/4	13720	349852	605217	28329	22867	10520	15593
4	14.00	S	NC40	5 1/16	2 27/32	5/16	13622	349852	694952	28329	22703	10520	15593
4	14.00	S	NC46	5 1/2	3 21/32	1/4	13815	349852	636737	28329	23025	10520	15593
4	14.00	V	NC46	5 9/16	3 9/16	9/32	15280	388725	700520	31496	25467	11035	17325
4	15.70	E	4 H90	4 29/32	3 11/16	5/32	8296	219738	377420	17315	13826	9531	9975
4	15.70	E	NC40	4 25/32	3 9/32	11/64	8440	219738	442397	17315	14067	9531	9975
4	15.70	E	NC46	5 1/4	3 31/32	5/32	8539	219738	412162	17315	14232	9531	9975
4	15.70	X	4 H90	5 1/32	3 17/32	3/16	10830	278335	483725	21932	18050	11468	12635
4	15.70	X	NC40	4 29/32	3 3/32	15/64	10737	278335	555053	21932	17895	11468	12635
4	15.70	X	NC46	5 11/32	3 27/32	11/64	10652	278335	504201	21932	17753	11468	12635
4	15.70	G	4 H90	5 1/16	3 15/32	13/64	11760	307633	524959	24241	19600	12374	13965
4	15.70	G	NC40	4 31/32	3	17/64	11843	307633	608896	24241	19738	12374	13965
4	15.70	G	NC46	5 13/32	3 25/32	13/64	11815	307633	549116	24241	19691	12374	13965
4	15.70	S	NC46	5 17/32	3 9/16	17/64	15039	395528	700520	31166	25066	14840	17955
4	15.70	S	NC46	5 17/32	3 9/16	17/64	15039	395528	700520	31166	25066	14840	17955
4 1/2	13.75	E	4 1/2 H90	5 7/32	4 1/16	5/32	8858	185389	378165	17715	14764	3397	6323
4 1/2	13.75	E	4 1/2 OH SW	5 5/16	4 5/32	5/32	8915	185389	411263	17715	14858	3397	6323
4 1/2	13.75	E	4 1/2 WO	5 21/32	4 13/32	5/32	9111	185389	401491	17715	15185	3397	6323
4 1/2	13.75	E	NC46	5 1/4	3 31/32	5/32	8539	185389	412162	17715	14232	3397	6323

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
4 1/2	13.75	E	NC50	5 21/32	4 15/32	5/32	8645	185389	382353	17715	14408	3397	6323
4 1/2	16.60	E	4 1/2 FH	5 9/32	3 3/4	5/32	10050	225771	499026	20908	16750	5951	7863
4 1/2	16.60	E	4 1/2 H90	5 9/32	4	5/32	10045	225771	425657	20908	16742	5951	7863
4 1/2	16.60	E	4 1/2 OH SW	5 3/8	4 3/32	11/64	10188	225771	459860	20908	16979	5951	7863
4 1/2	16.60	E	NC38	4 11/16	2 3/4	17/64	10217	225771	555278	20908	17028	5951	7863
4 1/2	16.60	E	NC46	5 11/32	3 7/8	11/64	10280	225771	481467	20908	17133	5951	7863
4 1/2	16.60	E	NC50	5 11/16	4 3/8	5/32	10537	225771	460494	20908	17562	5951	7863
4 1/2	16.60	SS75	NC46	5 3/8	3 13/16	3/16	10364	225771	482854	20908	17274	5951	7863
4 1/2	16.60	SS75	NC50	5 23/32	4 11/32	5/32	10232	225771	445658	20908	17053	5951	7863
4 1/2	16.60	X	4 1/2 FH	5 13/32	3 9/16	7/32	12821	285977	628249	26483	21368	6828	9960
4 1/2	16.60	X	4 1/2 H90	5 3/8	3 27/32	3/16	12950	285977	541166	26483	21583	6828	9960
4 1/2	16.60	X	NC46	5 7/16	3 23/32	7/32	12818	285977	593294	26483	21363	6828	9960
4 1/2	16.60	X	NC50	5 25/32	4 1/4	3/16	13015	285977	562104	26483	21691	6828	9960
4 1/2	16.60	SS95	NC46	5 1/2	3 5/8	1/4	13102	285977	603333	26483	21836	6828	9960
4 1/2	16.60	SS95	NC50	5 13/16	4 3/16	13/64	12898	285977	560822	26483	21497	6828	9960
4 1/2	16.60	G	4 1/2 FH	5 15/32	3 15/32	1/4	14231	316080	690375	29271	23718	7185	11009
4 1/2	16.60	G	4 1/2 H90	5 7/16	3 25/32	7/32	14086	316080	586081	29271	23477	7185	11009
4 1/2	16.60	G	NC46	5 1/2	3 5/8	1/4	14293	316080	658182	29271	23821	7185	11009
4 1/2	16.60	G	NC50	5 13/16	4 3/16	13/64	14071	316080	611805	29271	23451	7185	11009
4 1/2	16.60	SS105	NC46	5 9/16	3 17/32	9/32	14448	316080	661295	29271	24081	7185	11009
4 1/2	16.60	S	4 1/2 FH	5 21/32	3 3/16	11/32	18162	406388	866814	37634	30270	7923	14154
4 1/2	16.60	S	4 1/2 H90	5 19/32	3 17/32	19/64	18480	406388	758377	37634	30800	7923	14154
4 1/2	16.60	S	NC46	5 21/32	3 3/8	21/64	18088	406388	823115	37634	30146	7923	14154
4 1/2	16.60	S	NC50	5 31/32	3 31/32	9/32	18355	406388	779960	37634	30592	7923	14154

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4 1/2	16.60	V	NC46	5 3/4	3 7/32	3/8	20382	451542	920216	41841	33971	8098	15727
4 1/2	16.60	V	NC50	6 1/32	3 7/8	5/16	20113	451542	849266	41841	33522	8098	15727
4 1/2	20.00	E	4 1/2 FH	5 3/8	3 5/8	13/64	11944	279502	585911	24747	19907	9631	10033
4 1/2	20.00	E	4 1/2 H90	5 11/32	3 7/8	11/64	12207	279502	518432	24747	20345	9631	10033
4 1/2	20.00	E	NC46	5 13/32	3 3/4	13/64	12090	279502	571297	24747	20150	9631	10033
4 1/2	20.00	E	NC50	5 3/4	4 9/32	11/64	12401	279502	536978	24747	20668	9631	10033
4 1/2	20.00	SS75	NC46	5 15/32	3 11/16	15/64	12210	279502	563849	24747	20350	9631	10033
4 1/2	20.00	SS75	NC50	5 25/32	4 1/4	3/16	11930	279502	515262	24747	19884	9631	10033
4 1/2	20.00	X	4 1/2 FH	5 1/2	3 13/32	17/64	14945	354035	730872	31346	24908	11598	12709
4 1/2	20.00	X	4 1/2 H90	5 15/32	3 23/32	15/64	15208	354035	630259	31346	25346	11598	12709
4 1/2	20.00	X	NC46	5 9/16	3 9/16	9/32	15280	354035	700520	31346	25467	11598	12709
4 1/2	20.00	X	NC50	5 7/8	4 1/8	15/64	15438	354035	660770	31346	25730	11598	12709
4 1/2	20.00	SS95	NC46	5 19/32	3 15/32	19/64	15172	354035	699092	31346	25287	11598	12709
4 1/2	20.00	SS95	NC50	5 29/32	4 1/16	1/4	15237	354035	649915	31346	25394	11598	12709
4 1/2	20.00	G	4 1/2 FH	5 19/32	3 9/32	5/16	16885	391302	809657	34645	28142	12520	14047
4 1/2	20.00	G	4 1/2 H90	5 17/32	3 5/8	17/64	16861	391302	695147	34645	28102	12520	14047
4 1/2	20.00	G	NC46	5 5/8	3 15/32	5/16	16714	391302	762646	34645	27857	12520	14047
4 1/2	20.00	G	NC50	5 15/16	4 1/16	17/64	16628	391302	708998	34645	27714	12520	14047
4 1/2	20.00	SS105	NC46	5 11/16	3 11/32	11/32	17029	391302	772662	34645	28382	12520	14047
4 1/2	20.00	S	NC46	5 13/16	3 1/8	13/32	21697	503103	976268	44544	36162	15033	18060
4 1/2	20.00	S	NC50	6 3/32	3 25/32	11/32	21806	503103	916914	44544	36343	15033	18060
4 1/2	20.00	V	NC46	5 29/32	2 31/32	29/64	23814	559003	1066006	49523	39690	16139	20067
4 1/2	20.00	V	NC50	6 3/16	3 21/32	25/64	24009	559003	1004535	49523	40015	16139	20067
4 1/2	22.82	E	NC46	5 15/32	3 11/16	15/64	13320	317497	615108	27161	22200	11458	11667

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Ec-centric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
4 1/2	22.82	E	NC50	5 25/32	4 7/32	3/16	13234	317497	587047	27161	22056	11458	11667
4 1/2	22.82	X	4 1/2 FH	5 19/32	3 9/32	5/16	16885	402163	809657	34404	28142	14514	14779
4 1/2	22.82	X	NC46	5 19/32	3 15/32	19/64	16551	402163	762646	34404	27585	14514	14779
4 1/2	22.82	X	NC50	5 29/32	4 1/16	1/4	16622	402163	708998	34404	27703	14514	14779
4 1/2	22.82	G	NC46	5 11/16	3 11/32	11/32	18577	444496	842904	38026	30962	16042	16333
4 1/2	22.82	G	NC50	5 31/32	3 31/32	9/32	18355	444496	779960	38026	30592	16042	16333
4 1/2	22.82	S	NC50	6 5/32	3 21/32	3/8	23717	571495	1004535	48890	39528	20510	21000
5	19.50	E	5 1/2 FH	6 5/16	4 7/8	5/32	13461	270432	533909	27976	22434	5514	7602
5	19.50	E	NC50	5 13/16	4 7/32	13/64	13626	270432	587047	27976	22710	5514	7602
5	19.50	X	5 1/2 FH	6 13/32	4 23/32	13/64	17134	342548	675188	35436	28556	6262	9629
5	19.50	X	5 H90	5 25/32	3 31/32	1/4	17451	342548	686973	35436	29084	6262	9629
5	19.50	X	NC50	5 15/16	4 1/32	17/64	17218	342548	732837	35436	28697	6262	9629
5	19.50	G	5 1/2 FH	6 15/32	4 5/8	15/64	19179	378605	757747	39166	31965	6552	10643
5	19.50	G	5 H90	5 27/32	3 7/8	9/32	19307	378605	756279	39166	32179	6552	10643
5	19.50	G	NC50	6	3 15/16	19/64	18966	378605	803246	39166	31611	6552	10643
5	19.50	S	5 1/2 FH	6 5/8	4 13/32	5/16	24420	486778	943942	50356	40699	7079	13684
5	19.50	S	NC50	6 3/16	3 5/8	25/64	24550	486778	1025980	50356	40916	7079	13684
5	25.60	E	5 1/2 FH	6 13/32	4 23/32	13/64	17134	358731	675188	34947	28556	10338	10500
5	25.60	E	NC50	5 15/16	4 1/32	17/64	17218	358731	732837	34947	28697	10338	10500
5	25.60	SS75	5 1/2 FH	6 15/32	4 21/32	15/64	17175	358731	669544	34947	28625	10338	10500
5	25.60	SS75	NC50	5 31/32	3 31/32	9/32	16826	358731	714964	34947	28043	10338	10500
5	25.60	X	5 1/2 FH	6 17/32	4 17/32	17/64	21253	454392	838649	44267	35422	12640	13300
5	25.60	X	NC50	6 3/32	3 25/32	11/32	21806	454392	916914	44267	36343	12640	13300
5	25.60	SS95	5 1/2 FH	6 19/32	4 7/16	19/64	21410	454392	841403	44267	35684	12640	13300

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
5	25.60	G	5 1/2 FH	6 5/8	4 7/16	19/64	23826	502223	917895	48926	39710	13685	14700
5	25.60	G	NC50	6 5/32	3 21/32	3/8	23717	502223	1004535	48926	39528	13685	14700
5	25.60	S	5 1/2 FH	6 13/16	4 1/8	13/32	30757	645715	1170081	62905	51261	16587	18900
5	25.60	V	5 1/2 FH	6 29/32	3 31/32	29/64	34065	717461	1289271	69937	56774	17896	21000
5	TW 0.750	SS95	5 1/2 FH	6 25/32	4 3/16	25/64	26953	630665	1027690	54938	44922	19393	19950
5	TW 0.750	V	5 1/2 FH	7 1/8	3 9/16	9/16	42151	995787	1577629	86744	70252	30621	31500
5 1/2	21.90	E	5 1/2 FH	6 13/32	4 23/32	13/64	17134	299533	675188	34582	28556	4334	6892
5 1/2	21.90	SS75	5 1/2 FH	6 7/16	4 21/32	7/32	16640	299533	669544	34582	27733	4334	6892
5 1/2	21.90	X	5 1/2 FH	6 17/32	4 17/32	17/64	21253	379409	838649	43804	35422	4733	8730
5 1/2	21.90	X	5 1/2 H90	6 3/32	4 5/32	9/32	21301	379409	795031	43804	35501	4733	8730
5 1/2	21.90	SS95	5 1/2 FH	6 19/32	4 15/32	19/64	21185	379409	817358	43804	35308	4733	8730
5 1/2	21.90	G	5 1/2 FH	6 19/32	4 7/16	19/64	23357	419346	917895	48414	38928	4899	9649
5 1/2	21.90	S	5 1/2 FH	6 13/16	4 5/32	13/32	30082	539160	1145691	62247	50137	5465	12405
5 1/2	21.90	V	5 1/2 FH	6 29/32	4	29/64	33412	599066	1265801	69206	55686	5607	13784
5 1/2	24.70	E	5 1/2 FH	6 15/32	4 21/32	15/64	18736	339533	730411	38383	31227	6050	7923
5 1/2	24.70	SS75	5 1/2 FH	6 1/2	4 19/32	1/4	18526	339533	719490	38383	30876	6050	7923
5 1/2	24.70	X	5 1/2 FH	6 19/32	4 7/16	19/64	23357	430076	917895	48619	38928	6957	10035
5 1/2	24.70	SS95	5 1/2 FH	6 21/32	4 11/32	21/64	23365	430076	912526	48619	38942	6957	10035
5 1/2	24.70	G	5 1/2 FH	6 11/16	4 11/32	11/32	25948	475347	995483	53737	43247	7329	11092
5 1/2	24.70	S	5 1/2 FH	6 7/8	4	7/16	33187	611160	1265801	69090	55311	8115	14261
5 1/2	24.70	V	5 1/2 FH	7	3 13/16	1/2	37264	679067	1403860	76813	62107	8316	15845
5 1/2	TW 0.500	V	5 1/2 FH	7 1/8	3 9/16	9/16	42151	799928	1577629	87501	70252	14313	19091
5 1/2	TW 0.625	V	5 1/2 FH	7 9/32	3 7/32	41/64	48389	966408	1797326	100541	80648	23349	23864
5 1/2	TW 0.750	V	5 1/2 FH	7 13/32	2 29/32	45/64	53416	1119487	1977722	110662	89026	27946	28636

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	**Max. ID Tool Joint** (in.)	**Min. Box Shoulder Width Eccentric Wear** [b] (in.)	**Make-up Torque at Min. OD & Max. ID** [c] (ft-lb)	**Tensile Yield Pipe Body** (lb)	**Tensile Yield Tool Joint** (lb)	**Torsional Yield Pipe Body** (ft-lb)	**Torsional Yield Tool Joint** (ft-lb)	**Collapse Pressure Pipe Body** (psi)	**Max. Internal Pressure Pipe Body** (psi)
5 7/8	23.40	E	5 1/2 FH	6 1/2	4 5/8	1/4	19475	321861	757747	40073	32458	3608	6452
5 7/8	23.40	X	5 1/2 FH	6 5/8	4 13/32	5/16	24420	407691	943942	50759	40699	4029	8172
5 7/8	23.40	G	5 1/2 FH	6 23/32	4 9/32	23/64	27343	450605	1046289	56103	45571	4219	9033
5 7/8	23.40	S	5 1/2 FH	6 15/16	3 15/16	15/32	34713	579350	1312557	72132	57855	4557	11613
5 7/8	23.40	V	5 1/2 FH	7 1/32	3 3/4	33/64	38513	643722	1448407	80147	64188	4582	12904
5 7/8	26.30	E	5 1/2 FH	6 9/16	4 17/32	9/32	21668	365201	838649	44586	36113	5206	7417
5 7/8	26.30	X	5 1/2 FH	6 23/32	4 9/32	23/64	27343	462588	1046289	56475	45571	5862	9395
5 7/8	26.30	G	5 1/2 FH	6 13/16	4 5/32	13/32	30082	511282	1145691	62420	50137	6104	10384
5 7/8	26.30	S	5 1/2 FH	7 1/32	3 23/32	33/64	38908	657362	1470404	80254	64847	6566	13351
5 7/8	26.30	V	5 1/2 FH	7 5/32	3 1/2	37/64	43327	730403	1619231	89172	72212	6848	14834
5 7/8	TW 0.625	S	5 1/2 FH	7 11/32	3 1/16	43/64	50921	939348	1889825	106085	84868	18829	20106
5 7/8	TW 0.625	V	5 1/2 FH	7 1/2	2 11/16	3/4	56885	1043721	2093047	117872	94809	20437	22340
5 7/8	TW 0.750	S	5 1/2 FH	7 1/2	2 23/32	3/4	56425	1091036	2077124	117494	94042	23600	24128
5 7/8	TW 0.750	V	5 1/2 FH	7 21/32	2 1/4	53/64	62800	1212262	2296637	130549	104667	26223	26809
5 7/8	TW 0.813	S	5 1/2 FH	7 9/16	2 9/16	25/32	58677	1162915	2154897	122231	97795	25510	26154
5 7/8	TW 0.813	V	5 1/2 FH	7 23/32	2 1/32	55/64	65381	1292128	2384902	135812	108968	28344	29060
6 5/8	25.20	E	6 5/8 FH	7 3/8	5 5/8	7/32	24091	337236	822552	48497	40151	2227	5230
6 5/8	25.20	X	6 5/8 FH	7 1/2	5 7/16	9/32	29543	427166	1018042	61430	49238	2343	6625
6 5/8	25.20	G	6 5/8 FH	7 19/32	5 11/32	21/64	33341	472131	1113302	67896	55568	2346	7322
6 5/8	25.20	S	6 5/8 FH	7 25/32	5 1/16	27/64	42051	607026	1389143	87295	70084	2346	9414
6 5/8	25.20	V	6 5/8 FH	7 7/8	4 29/32	15/32	46709	674473	1535945	97053	77848	2346	10460
6 5/8	27.70	E	6 5/8 FH	7 13/32	5 19/32	15/64	25295	367455	855594	52308	42158	2765	5737
6 5/8	27.70	X	6 5/8 FH	7 9/16	5 3/8	5/16	32319	465443	1081733	66257	53865	3037	7267
6 5/8	27.70	G	6 5/8 FH	7 21/32	5 9/32	23/64	35308	514437	1175889	73231	58847	3113	8032

Label 1	Label 2	Grade	RSC Type	Class 2 Used Drill Pipe									
				Min. OD Tool Joint [a] (in.)	Max. ID Tool Joint (in.)	Min. Box Shoulder Width Eccentric Wear [b] (in.)	Make-up Torque at Min. OD & Max. ID [c] (ft-lb)	Tensile Yield Pipe Body (lb)	Tensile Yield Tool Joint (lb)	Torsional Yield Pipe Body (ft-lb)	Torsional Yield Tool Joint (ft-lb)	Collapse Pressure Pipe Body (psi)	Max. Internal Pressure Pipe Body (psi)
6 5/8	27.70	S	6 5/8 FH	7 27/32	4 15/16	29/64	45232	661419	1506953	94155	75386	3148	10327
6 5/8	27.70	V	6 5/8 FH	7 31/32	4 25/32	33/64	50380	734909	1650073	104679	83966	3148	11475
6 5/8	TW 0.522	V	6 5/8 FH	8 9/32	4 3/16	43/64	66636	1023915	2151961	138511	111060	9601	16546
6 5/8	TW 0.625	V	6 5/8 FH	8 15/32	3 13/16	49/64	75925	1198346	2434704	156715	126542	15660	19811
6 5/8	TW 0.750	V	6 5/8 FH	8 5/8	3 7/16	27/32	84423	1397812	2690940	175336	140705	23176	23774

[a] Any tool joint with an outside diameter less than the API bevel diameter should be provided with a minimum 1/32 in. x 45° bevel on the outside and inside diameter of the box shoulder and the outside diameter of the pin shoulder

[b] In calculation of torsional strengths of tool joints, both new and worn, the bevels of the tool joint shoulders are disregarded; this thickness measurement should be made in the plane of the face from the ID of the counterbore to the outside diameter of the box, disregarding the bevel.

[c] Normal torque range is tabulated value plus 10 %; higher torque values may be used under extreme conditions.

NOTE All calculated values are based on the equations provided in Annex G.

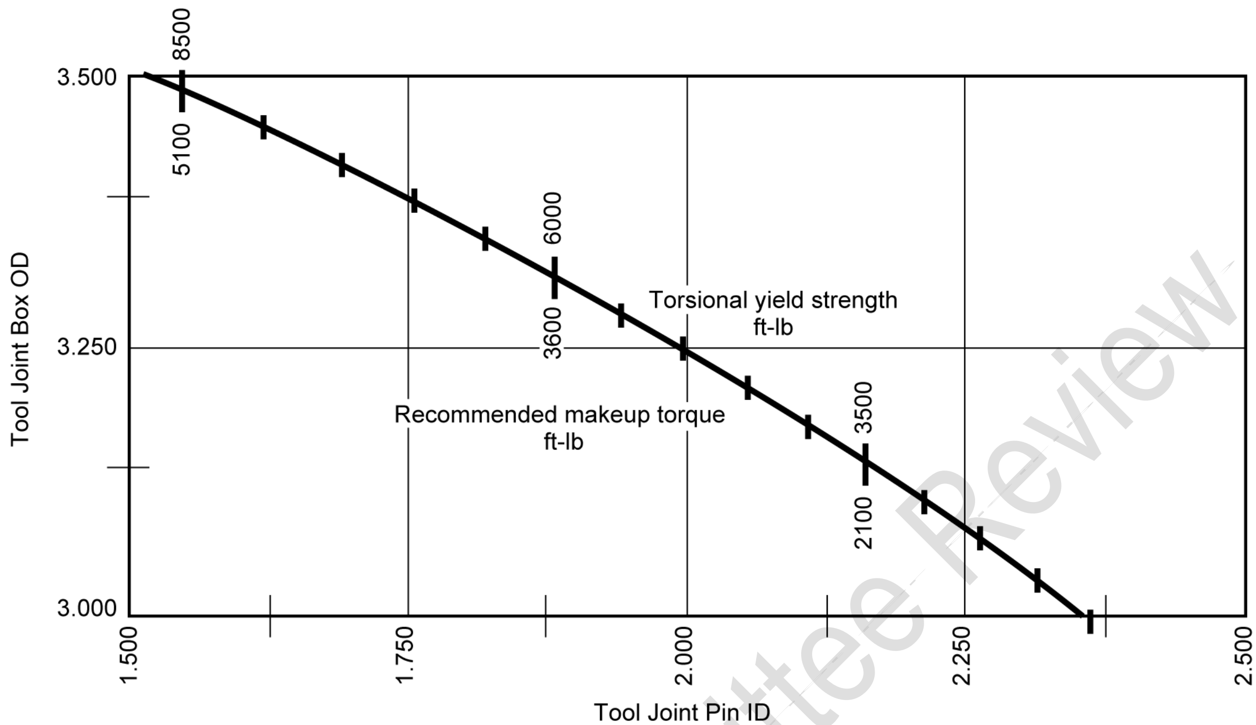


Figure A.1—NC26 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

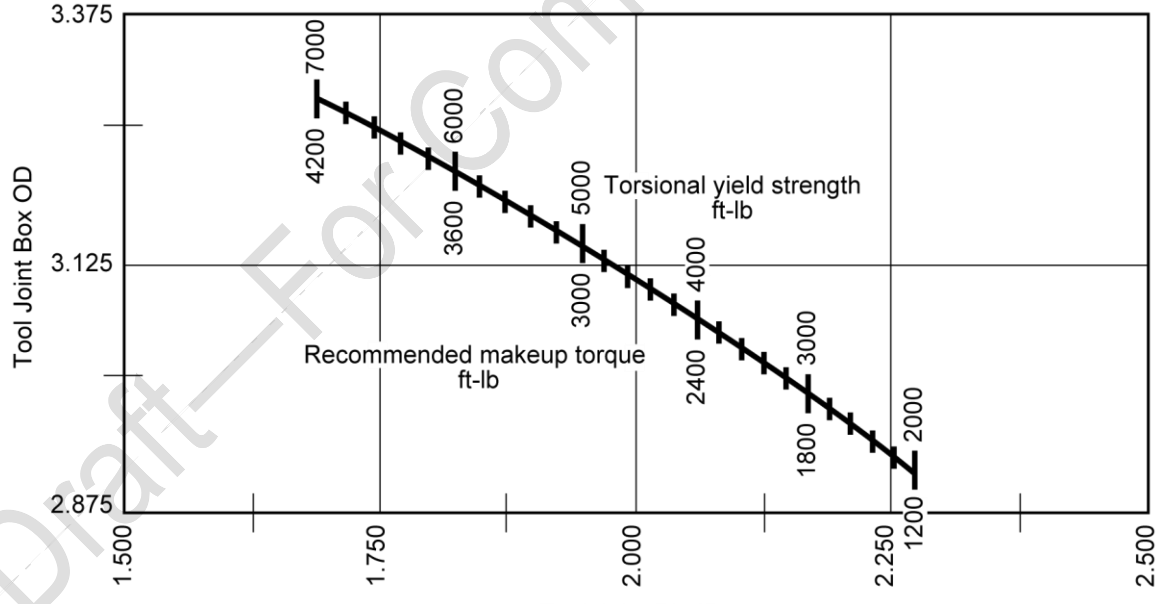


Figure A.2—2[3]/8 Open Hole Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

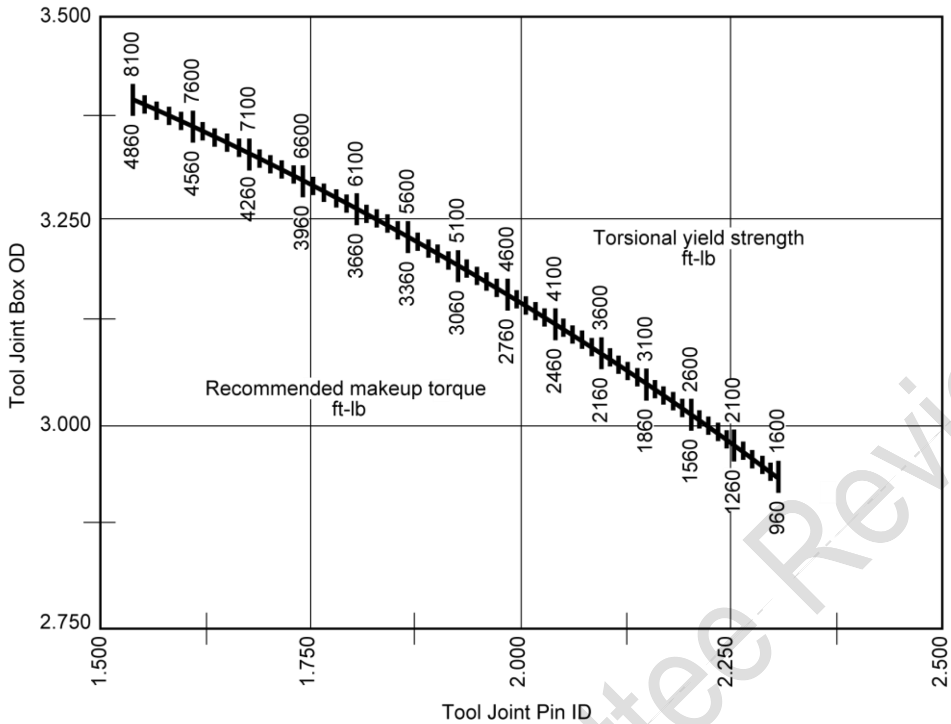


Figure A.3—2$^3/_8$ Wide Open Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

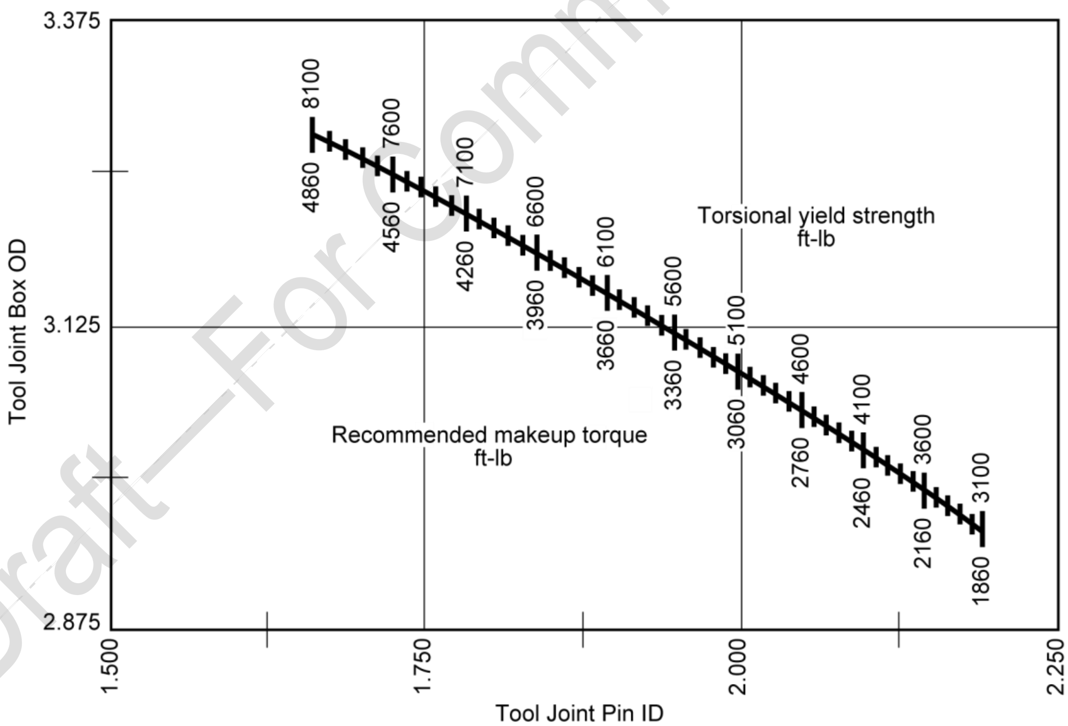


Figure A.4—2$^3/_8$ SLH90 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

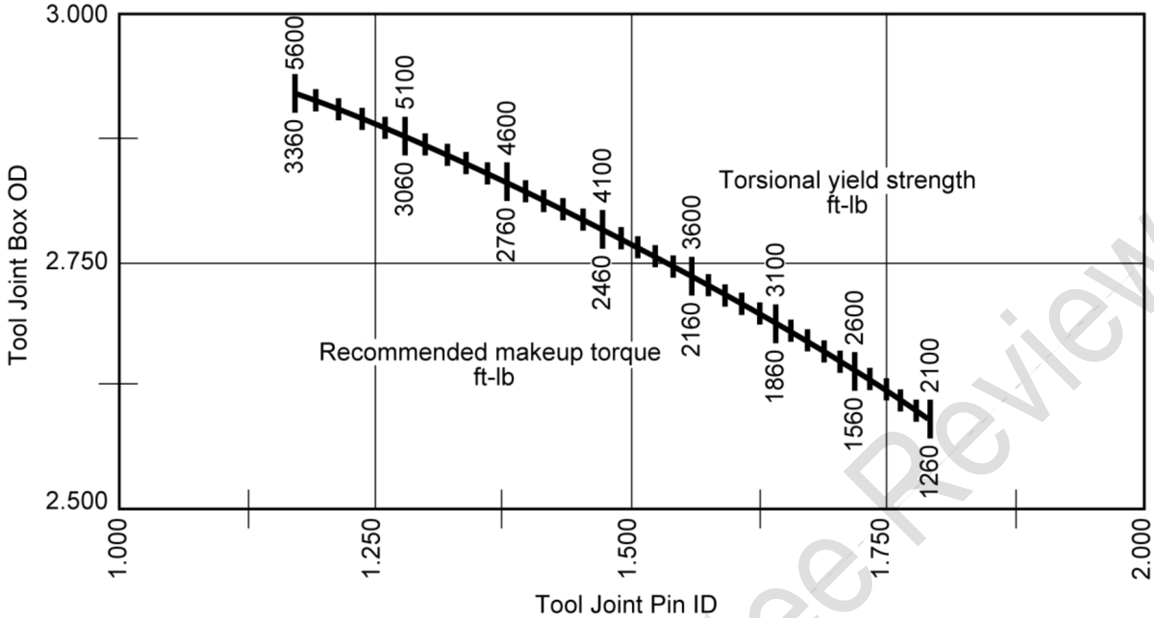


Figure A.5—2 3/8 PAC Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

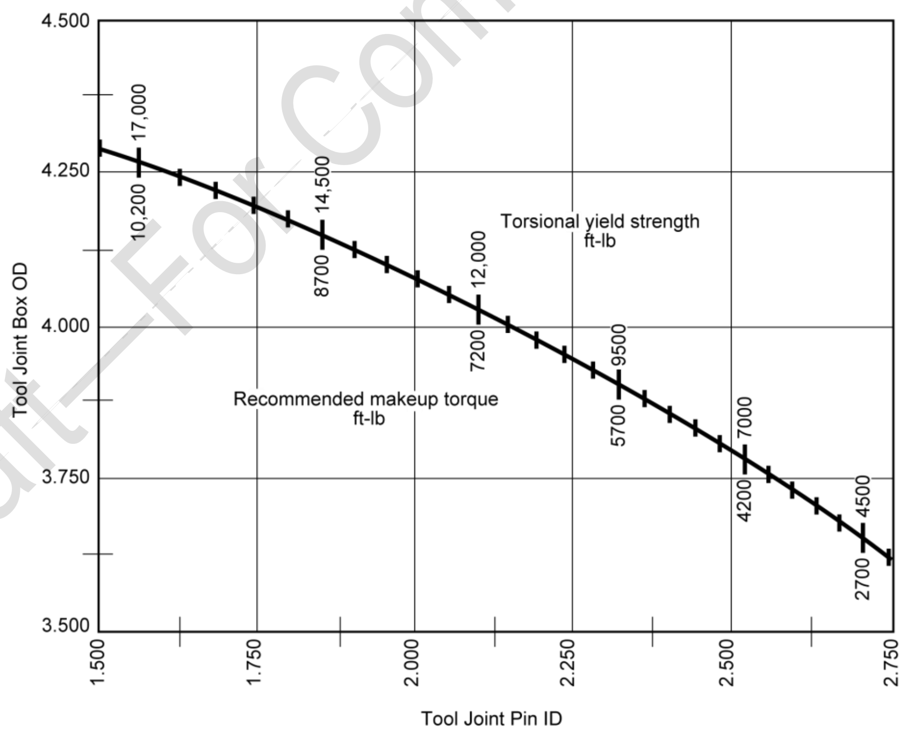


Figure A.6—NC31 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

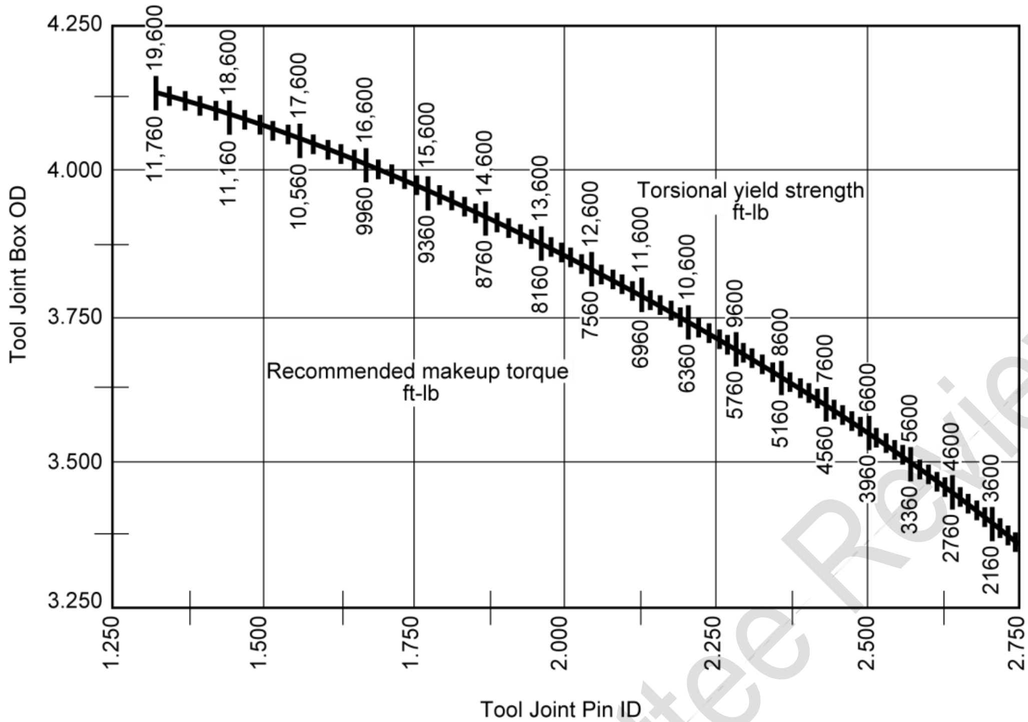


Figure A.7—2^7/8 SLH90 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

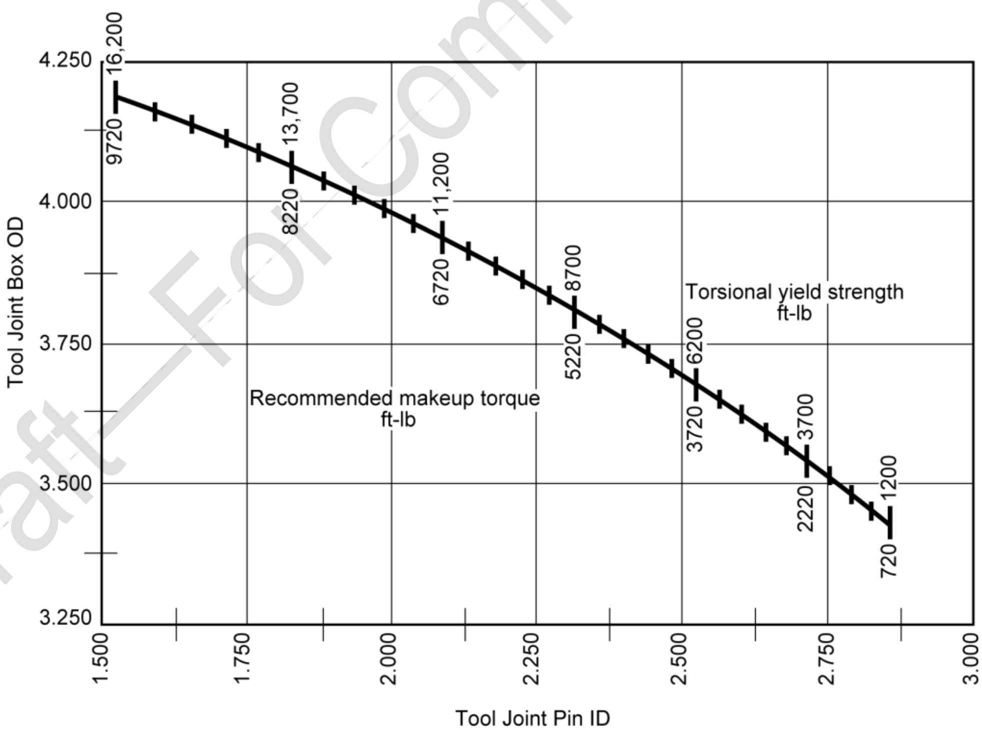


Figure A.8—2^7/8 Wide Open Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

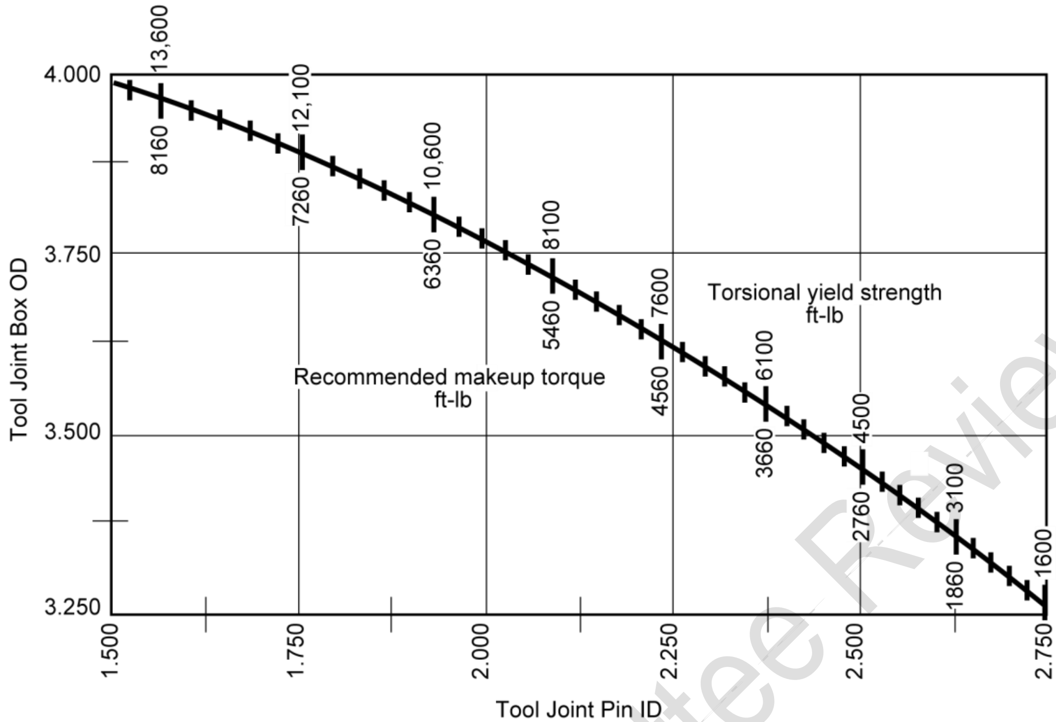


Figure A.9—2⁷/₈ Open Hole Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

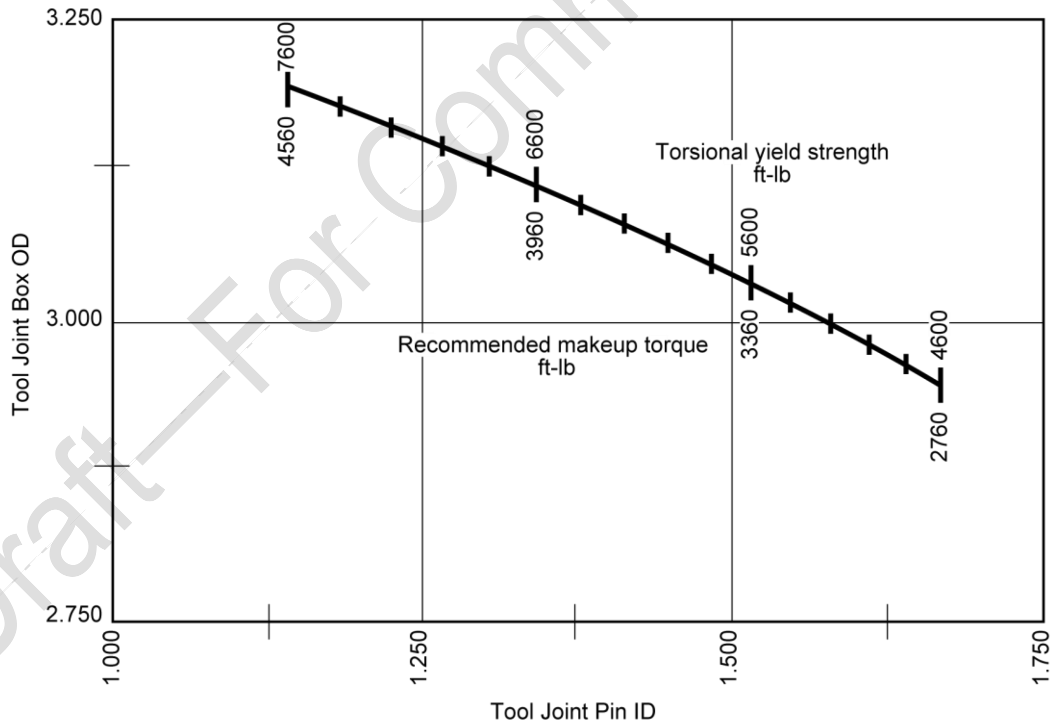


Figure A.10—2⁷/₈ PAC Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

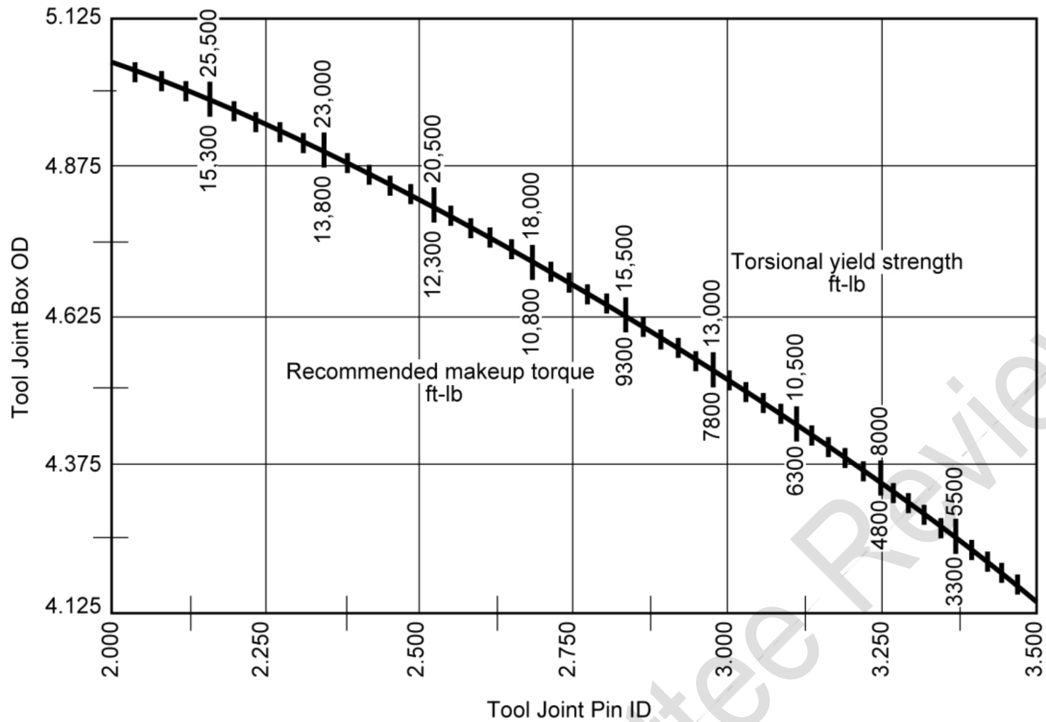


Figure A.11—NC38 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

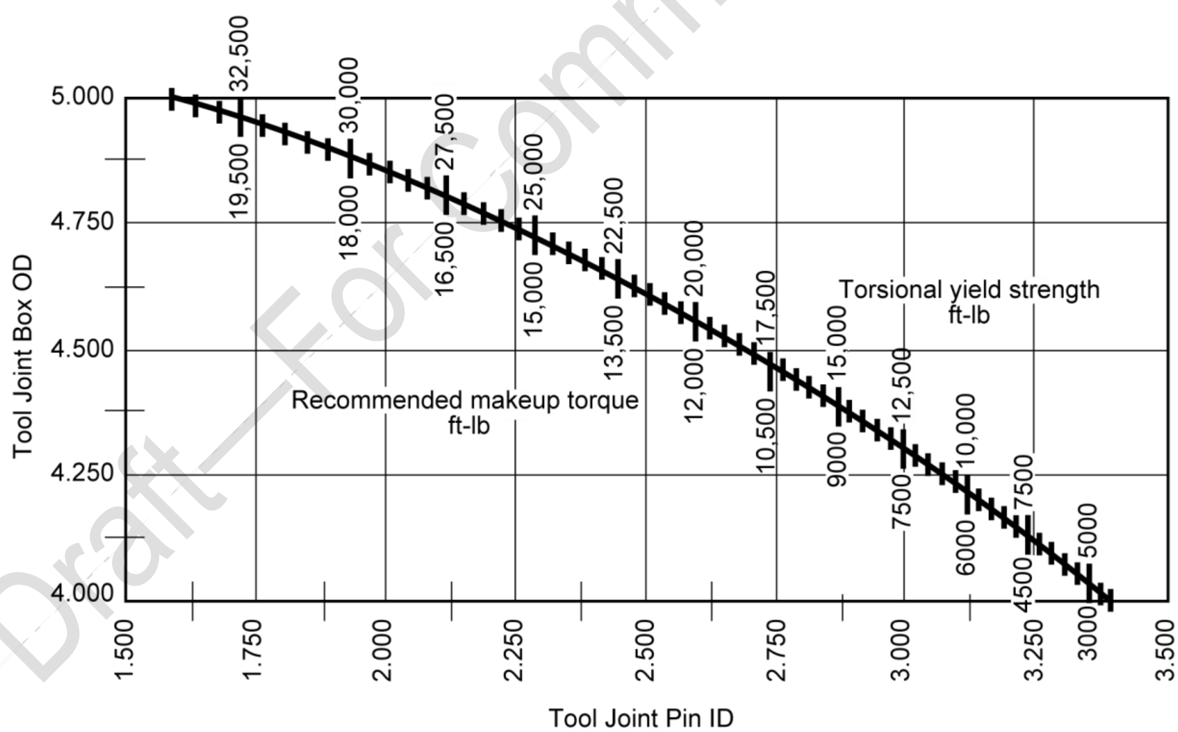


Figure A.12—3 $^1/_2$ SLH90 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

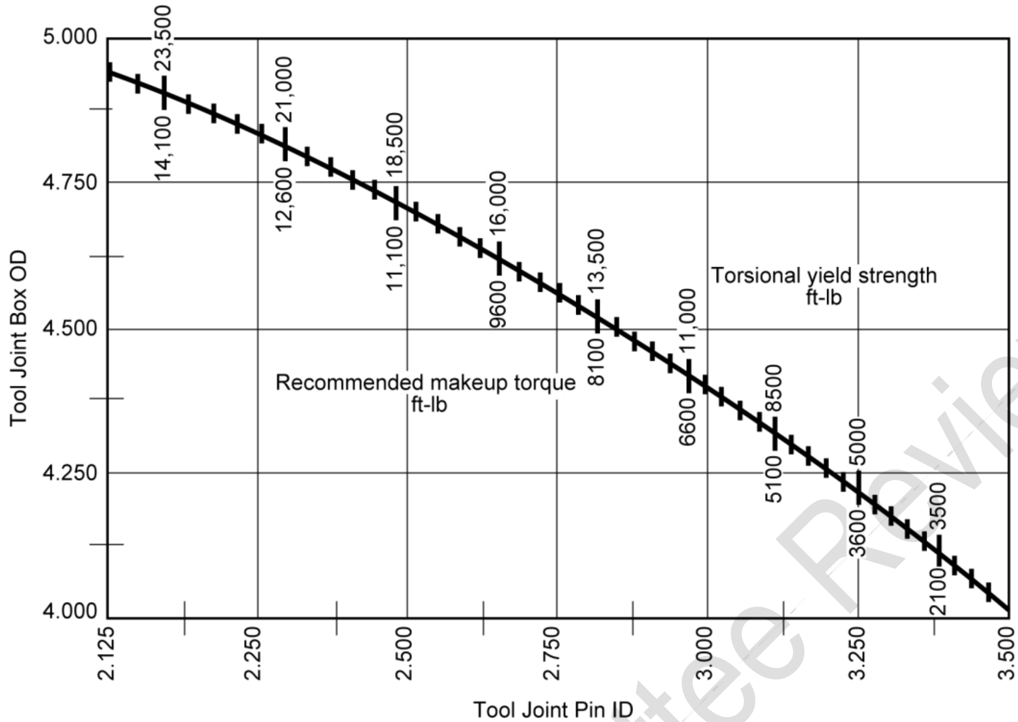


Figure A.13—3 1/2 FH Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

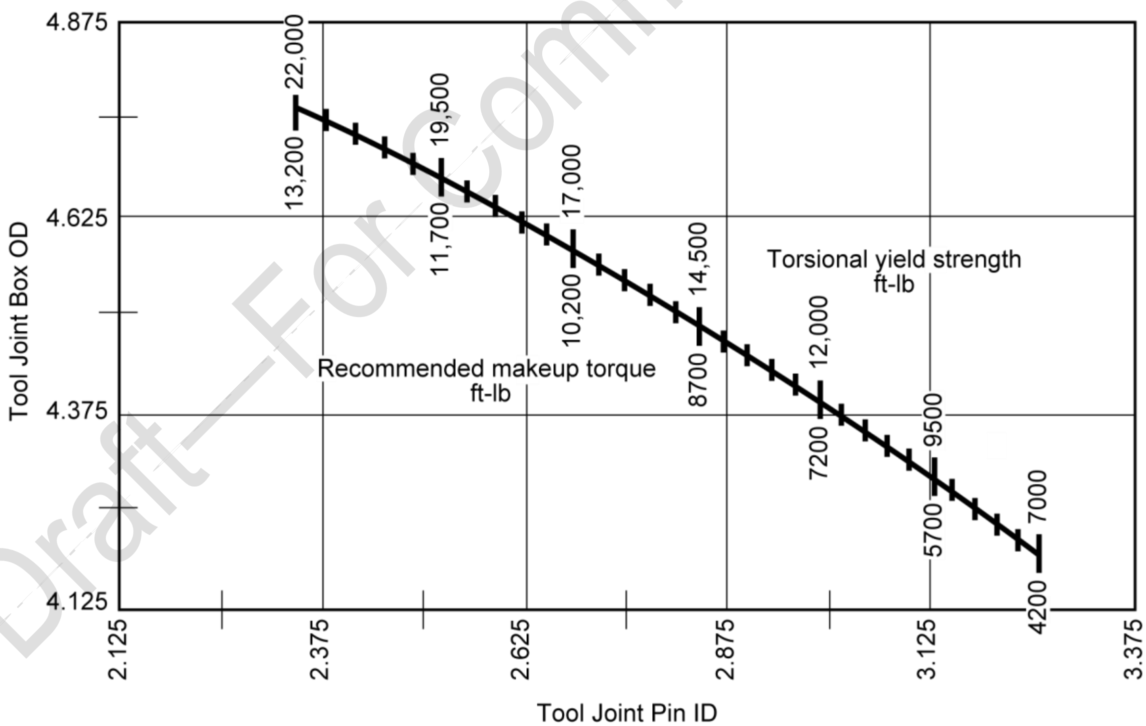


Figure A.14—3 1/2 Open Hole Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

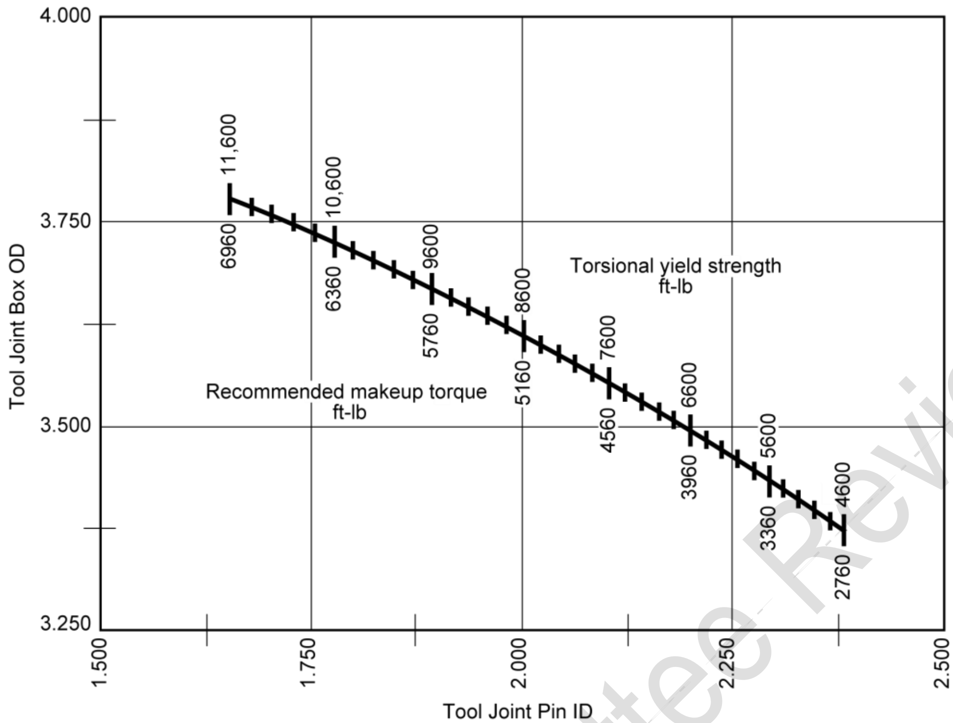


Figure A.15—3^1/$_2$ PAC Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

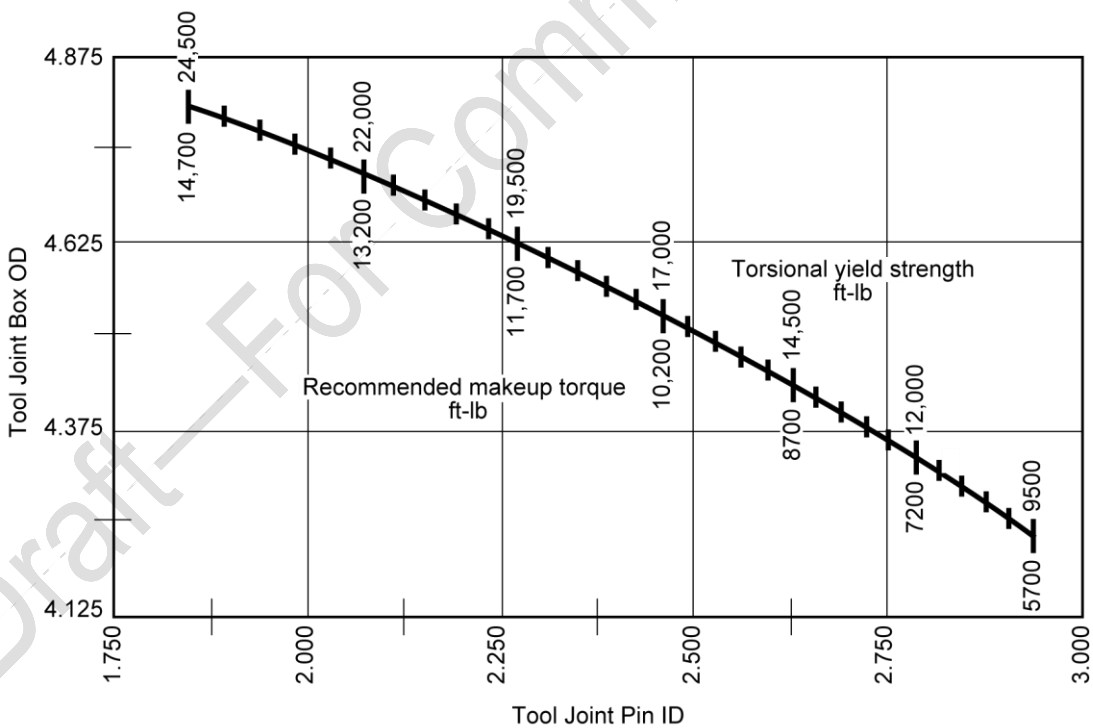


Figure A.16—3^1/$_2$ XH Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

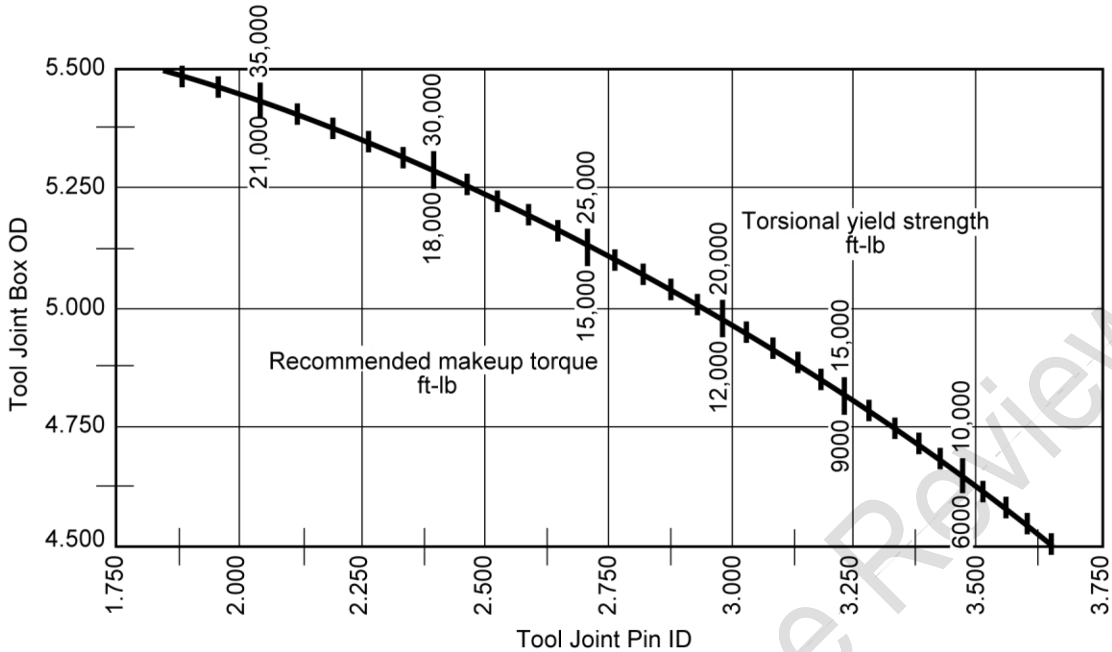


Figure A.17—NC40 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

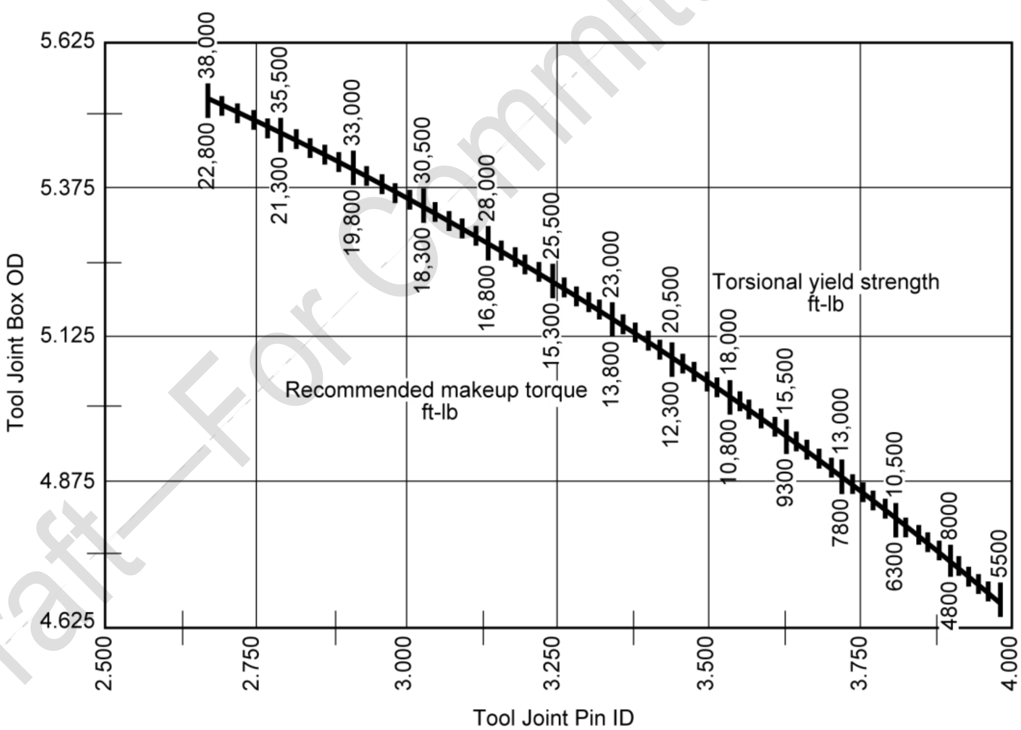


Figure A.18—4-in. H90 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

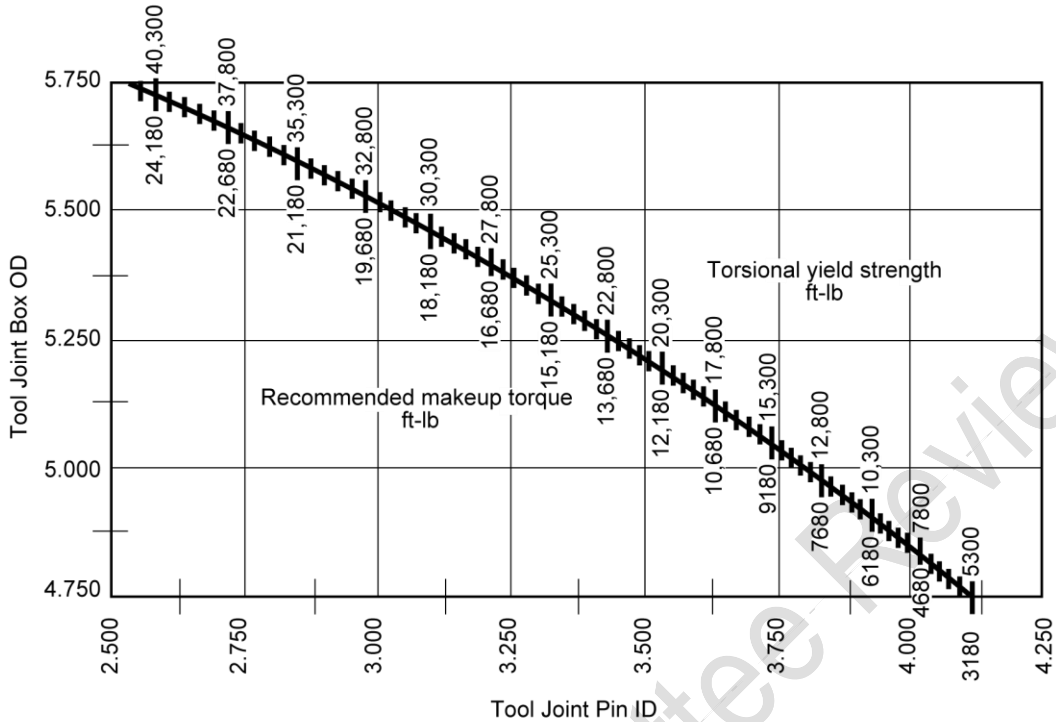


Figure A.19—4-in. Open Hole Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

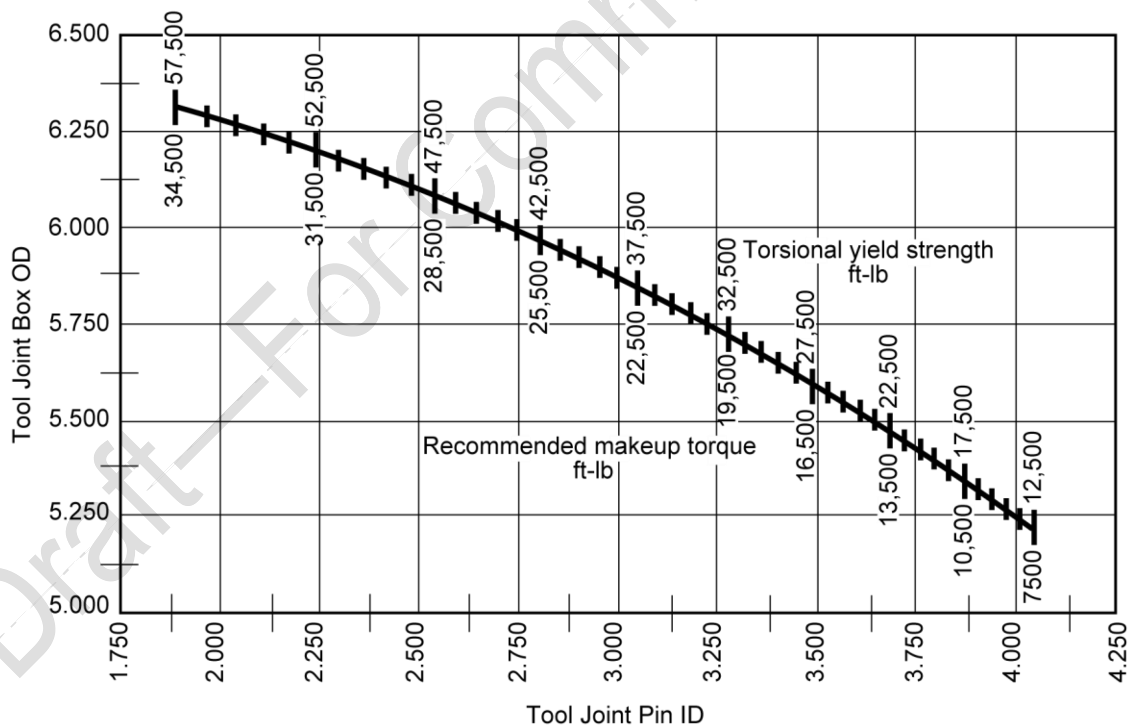


Figure A.20—NC46 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

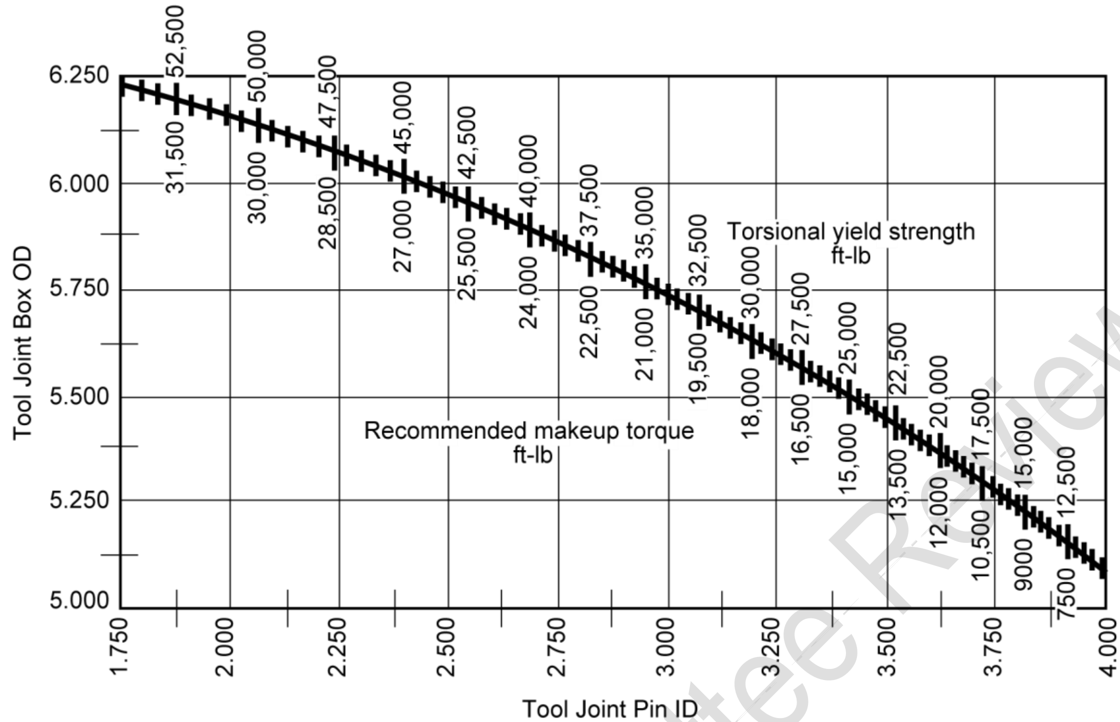


Figure A.21—4 1/2 FH Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

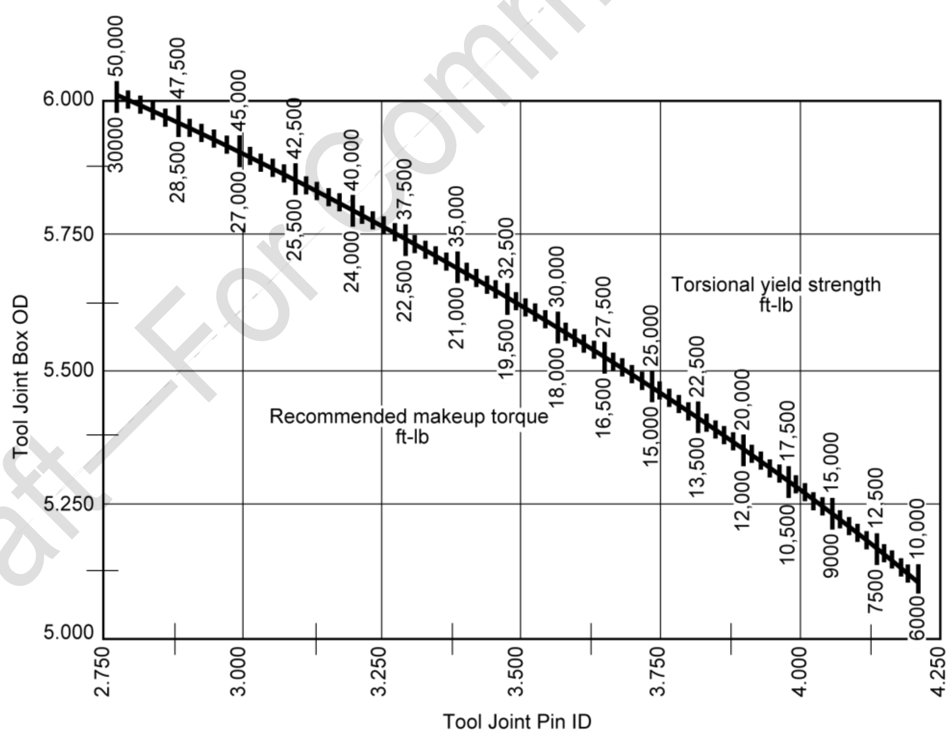


Figure A.22—4 1/2 H90 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

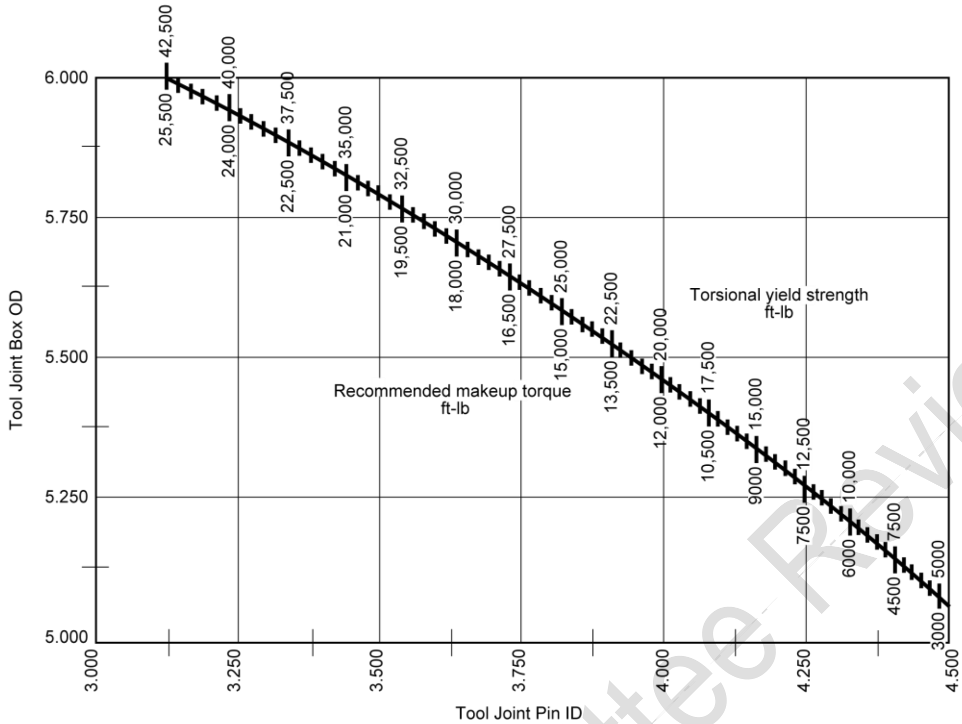


Figure A.23—4 1/2 Open Hole (Standard Weight) Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

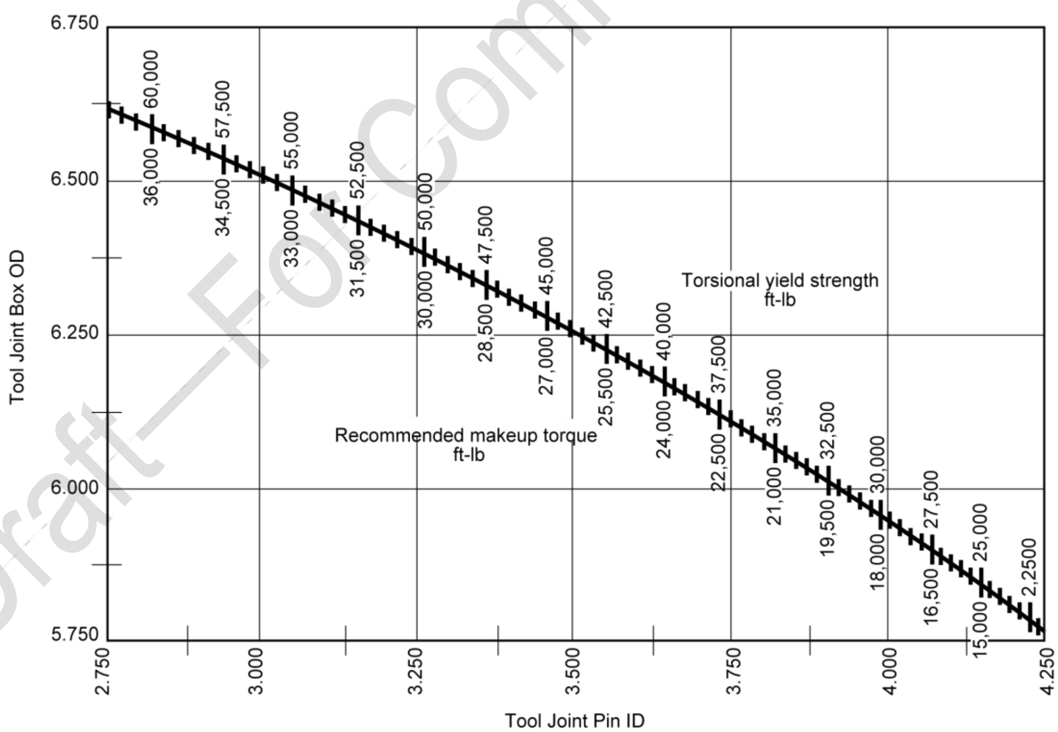


Figure A.24—NC50 Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

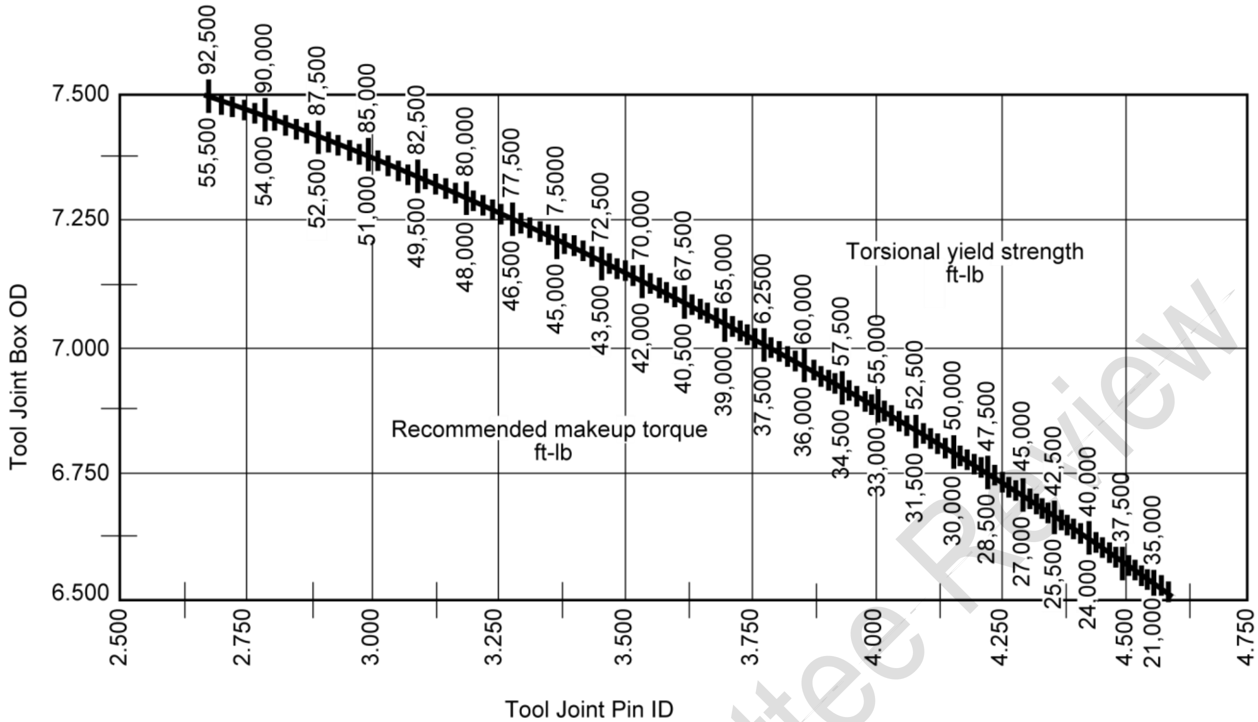


Figure A.25—5½ FH Torsional Yield and Make-up with 120,000 psi minimum YS Tool Joints

Annex B
(informative)

Properties of Drill Collars

Table B.1—Drill Collar Weight (Steel) (lb/ft)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Drill Collar OD (in.)	**Drill Collar ID** (in.)												
	1	**$1^1/_4$**	**$1^1/_2$**	**$1^3/_4$**	**2**	**$2^1/_4$**	**$2^1/_2$**	**$2^{13}/_{16}$**	**3**	**$3^1/_4$**	**$3^1/_2$**	**$3^3/_4$**	**4**
$2^7/_8$	19	18	16										
3	21	20	18										
$3^1/_8$	22	22	20										
$3^1/_4$	26	24	22										
$3^1/_2$	30	29	27										
$3^3/_4$	35	33	32										
4	40	39	37	35	32	29							
$4^1/_8$	43	41	39	37	35	32							
$4^1/_4$	46	44	42	40	38	35							
$4^1/_2$	51	50	48	46	43	41							
$4^3/_4$			54	52	50	47	44						
5			61	59	56	53	50						
$5^1/_4$			68	65	63	60	57						
$5^1/_2$			75	73	70	67	64	60					
$5^3/_4$			82	80	78	75	72	67	64	60			
6			90	88	85	83	79	75	72	68			
$6^1/_4$			98	96	94	91	88	83	80	76	72		
$6^1/_2$			107	105	102	99	96	91	89	85	80		
$6^3/_4$			116	114	111	108	105	100	98	93	89		
7			125	123	120	117	114	110	107	103	98	93	84
$7^1/_4$			134	132	130	127	124	119	116	112	108	103	93
$7^1/_2$			144	142	139	137	133	129	126	122	117	113	102
$7^3/_4$			154	152	150	147	144	139	136	132	128	123	112
8			165	163	160	157	154	150	147	143	138	133	122
$8^1/_4$			176	174	171	168	165	160	158	154	149	144	133
$8^1/_2$			187	185	182	179	176	172	169	165	160	155	150
9			210	208	206	203	200	195	192	188	184	179	174
$9^1/_2$			234	232	230	227	224	220	216	212	209	206	198
$9^3/_4$			248	245	243	240	237	232	229	225	221	216	211
10			261	259	257	254	251	246	243	239	235	230	225
11			317	315	313	310	307	302	299	295	291	286	281
12			379	377	374	371	368	364	361	357	352	347	342

NOTE Weight is calculated by: $0.2833 \cdot \frac{1}{4}\pi(OD^2 - ID^2) \cdot 12$

Table B.2—Recommended Make-up Torque for Rotary Shouldered Drill Collar Connections

Connection			Make-up Torque [a,b,c,d] (ft-lb)											
			Bore of Drill Collar (in.)											
Size	Type	OD (in.)	1	$1^{1}/_{4}$	$1^{1}/_{2}$	$1^{3}/_{4}$	2	$2^{1}/_{4}$	$2^{1}/_{2}$	$2^{13}/_{16}$	3	$3^{1}/_{4}$	$3^{1}/_{2}$	$3^{3}/_{4}$
API	NC23	3	* 2508	* 2508	* 2508									
		$3^{1}/_{8}$	* 3330	* 3330	2647									
		$3^{1}/_{4}$	4000	3387	2647									
$2^{3}/_{8}$	Regular	3		* 2241	* 2241	1749								
		$3^{1}/_{8}$		* 3028	2574	1749								
		$3^{1}/_{4}$		3285	2574	1749								
$2^{7}/_{8}$	PAC [e]	3		* 2713	* 2713	2090								
		$3^{1}/_{8}$		* 3548	2965	2090								
		$3^{1}/_{4}$		3719	2965	2090								
API	NC26	$3^{1}/_{2}$		* 4606	* 4606	3697								
		$3^{3}/_{4}$		5501	4668	3697								
$2^{7}/_{8}$	Regular	$3^{1}/_{2}$		* 3838	* 3838	* 3838								
		$3^{3}/_{4}$		5766	4951	4002								
		$3^{7}/_{8}$		5766	4951	4002								
$2^{7}/_{8}$	XH	$3^{3}/_{4}$		* 4089	* 4089	* 4089								
$3^{1}/_{2}$	DSL	$3^{7}/_{8}$		* 5352	* 5352	* 5352								
$2^{7}/_{8}$	Mod. Open	$4^{1}/_{8}$		* 8059	* 8059	7433								
API	NC31	$3^{7}/_{8}$		* 4640	* 4640	* 4640	* 4640							
		$4^{1}/_{8}$		* 7390	* 7390	* 7390	6853							
$3^{1}/_{2}$	Regular	$4^{1}/_{8}$		* 6466	* 6466	* 6466	* 6466	5685						
		$4^{1}/_{4}$		* 7886	* 7886	* 7886	7115	5685						
		$4^{1}/_{2}$		10,471	9514	8394	7115	5685						
API	NC31	$4^{1}/_{4}$		* 8858	* 8858	8161	6853	5391						
		$4^{1}/_{2}$		10,286	9307	8161	6853	5391						
API	NC35	$4^{1}/_{2}$				* 9038	* 9038	* 9038	7411					
		$4^{3}/_{4}$				12,273	10,826	9202	7411					
		5				12,273	10,826	9202	7411					
$3^{1}/_{2}$	XH	$4^{1}/_{4}$				* 5161	* 5161	* 5161	* 5161					
4	SH	$4^{1}/_{2}$				* 8479	* 8479	* 8479	8311					
$3^{1}/_{2}$	Mod. Open	$4^{3}/_{4}$				* 12,074	11,803	10,144	8311					
		5				13,283	11,803	10,144	8311					
		$5^{1}/_{4}$				13,283	11,803	10,144	8311					
API	NC38	$4^{3}/_{4}$				* 9986	* 9986	* 9986	* 9986	8315				
API	NC38	5				* 13,949	* 13,949	12,907	10,977	8315				

Connection			Make-up Torque [a,b,c,d] (ft-lb)											
			Bore of Drill Collar (in.)											
Size	**Type**	**OD** (in.)	**1**	**1 1/4**	**1 1/2**	**1 3/4**	**2**	**2 1/4**	**2 1/2**	**2 13/16**	**3**	**3 1/4**	**3 1/2**	**3 3/4**
		5 1/4				16,207	14,643	12,907	10,977	8315				
		5 1/2				16,207	14,643	12,907	10,977	8315				
3 1/2	H90	4 3/4				* 8786	* 8786	* 8786	* 8786	* 8786				
		5				* 12,794	* 12,794	* 12,794	* 12,794	10,408				
		5 1/4				* 17,094	16,929	15,137	13,151	10,408				
		5 1/2				18,522	16,929	15,137	13,151	10,408				
API	NC40	5				* 10,910	* 10,910	* 10,910	* 10,910	* 10,910				
		5 1/4				* 15,290	* 15,290	* 15,290	14,969	12,125				
4	Mod. Open	5 1/2				* 19,985	18,886	17,028	14,969	12,125				
API	NC40	5 3/4				20,539	18,886	17,028	14,969	12,125				
		6				20,539	18,886	17,028	14,969	12,125				
4	H90	5 1/4				* 12,590	* 12,590	* 12,590	* 12,590	* 12,590				
		5 1/2				* 17,401	* 17,401	* 17,401	* 17,401	16,536				
		5 3/4				* 22,531	* 22,531	21,714	19,543	16,536				
		6				25,408	23,671	21,714	19,543	16,536				
		6 1/4				25,408	23,671	21,714	19,543	16,536				
4 1/2	Regular	5 1/2				* 15,576	* 15,576	* 15,576	* 15,576	* 15,576				
		5 3/4				* 20,609	* 20,609	* 20,609	19,601	16,629				
		6				25,407	23,686	21,749	19,601	16,629				
		6 1/4				25,407	23,686	21,749	19,601	16,629				
API	NC44	5 3/4				* 20,895	* 20,895	* 20,895	* 20,895	18,161				
		6				* 26,453	25,510	23,493	21,257	18,161				
		6 1/4				27,300	25,510	23,493	21,257	18,161				
		6 1/2				27,300	25,510	23,493	21,257	18,161				
4 1/2	FH	5 1/2					* 12,973	* 12,973	* 12,973	* 12,973	* 12,973			
		5 3/4					* 18,119	* 18,119	* 18,119	* 18,119	17,900			
		6					* 23,605	* 23,605	23,028	19,921	17,900			
		6 1/4					27,294	25,272	23,028	19,921	17,900			
		6 1/2					27,294	25,272	23,028	19,921	17,900			

Connection			**Make-up Torque** [a,b,c,d] (ft-lb)											
Size	**Type**	**OD** (in.)	**Bore of Drill Collar** (in.)											
			1	**$1\frac{1}{4}$**	**$1\frac{1}{2}$**	**$1\frac{3}{4}$**	**2**	**$2\frac{1}{4}$**	**$2\frac{1}{2}$**	**$2\frac{13}{16}$**	**3**	**$3\frac{1}{4}$**	**$3\frac{1}{2}$**	**$3\frac{3}{4}$**
API	NC46	$5\frac{3}{4}$						* 17,738	* 17,738	* 17,738	* 17,738			
		6						* 23,422	* 23,422	22,426	20,311			
		$6\frac{1}{4}$						28,021	25,676	22,426	20,311			
$4\frac{1}{2}$	Semi IF	$6\frac{1}{2}$						28,021	25,676	22,426	20,311			
5	DSL	$6\frac{3}{4}$						28,021	25,676	22,426	20,311			
$4\frac{1}{2}$	H90	$5\frac{3}{4}$						* 18,019	* 18,019	* 18,019	* 18,019			
		6						* 23,681	* 23,681	23,159	21,051			
		$6\frac{1}{4}$						28,732	26,397	23,159	21,051			
		$6\frac{1}{2}$						28,732	26,397	23,159	21,051			
		$6\frac{3}{4}$						28,732	26,397	23,159	21,051			
5	H90	$6\frac{1}{4}$						* 25,360	* 25,360	* 25,360	* 25,360	23,988		
		$6\frac{1}{2}$						* 31,895	* 31,895	29,400	27,167	23,988		
		$6\frac{3}{4}$						35,292	32,825	29,400	27,167	23,988		
		7						35,292	32,825	29,400	27,167	23,988		
API	NC50	$6\frac{1}{4}$						* 23,004	* 23,004	* 23,004	* 23,004	* 23,004		
		$6\frac{1}{2}$						* 29,679	* 29,679	* 29,679	* 29,679	26,675		
		$6\frac{3}{4}$						* 36,742	35,824	32,277	29,966	26,675		
5	Mod. Open	7						38,379	35,824	32,277	29,966	26,675		
API	NC50	$7\frac{1}{4}$						38,379	35,824	32,277	29,966	26,675		
5	Semi-IF	$7\frac{1}{2}$						38,379	35,824	32,277	29,966	26,675		
$5\frac{1}{2}$	H90	$6\frac{3}{4}$						* 34,508	* 34,508	* 34,508	34,142	30,781		
		7						* 41,993	40,117	36,501	34,142	30,781		
		$7\frac{1}{4}$						42,719	40,117	36,501	34,142	30,781		
		$7\frac{1}{2}$						42,719	40,117	36,501	34,142	30,781		
$5\frac{1}{2}$	Regular	$6\frac{3}{4}$						* 31,941	* 31,941	* 31,941	* 31,941	30,495		
		7						* 39,419	* 39,419	36,235	33,868	30,495		
		$7\frac{1}{4}$						42,481	39,866	36,235	33,868	30,495		
		$7\frac{1}{2}$						42,481	39,866	36,235	33,868	30,495		

Connection			Make-up Torque [a,b,c,d] (ft-lb)											
			Bore of Drill Collar (in.)											
Size	Type	OD (in.)	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 13/16	3	3 1/4	3 1/2	3 3/4
5 1/2	FH	7						* 32,762	* 32,762	* 32,762	* 32,762	* 32,762		
		7 1/4						* 40,998	* 40,998	* 40,998	* 40,998	* 40,998		
		7 1/2						* 49,661	* 49,661	47,756	45,190	41,533		
		7 3/4						54,515	51,687	47,756	45,190	41,533		
API	NC56	7 1/4							* 40,498	* 40,498	* 40,498	* 40,498		
		7 1/2							* 49,060	48,221	45,680	42,058		
		7 3/4							52,115	48,221	45,680	42,058		
		8							52,115	48,221	45,680	42,058		
6 5/8	Regular	7 1/2							* 46,399	* 46,399	* 46,399	* 46,399		
		7 3/4							* 55,627	53,346	50,704	46,936		
		8							57,393	53,346	50,704	46,936		
		8 1/4							57,393	53,346	50,704	46,936		
6 5/8	H90	7 1/2							* 46,509	* 46,509	* 46,509	* 46,509		
		7 3/4							* 55,708	* 55,708	53,629	49,855		
		8							60,321	56,273	53,629	49,855		
		8 1/4							60,321	56,273	53,629	49,855		
API	NC61	8							* 55,131	* 55,131	* 55,131	* 55,131		
		8 1/4							* 65,438	* 65,438	* 65,438	61,624		
		8 1/2							72,670	68,398	65,607	61,624		
		8 3/4							72,670	68,398	65,607	61,624		
		9							72,670	68,398	65,607	61,624		
5 1/2	IF	8							* 56,641	* 56,641	* 56,641	* 56,641	* 56,641	
		8 1/4							* 67,133	* 67,133	* 67,133	63,381	59,027	
		8 1/2							74,626	70,277	67,436	63,381	59,027	
		8 3/4							74,626	70,277	67,436	63,381	59,027	
		9							74,626	70,277	67,436	63,381	59,027	
		9 1/4							74,626	70,277	67,436	63,381	59,027	
6 5/8	FH	8 1/2							* 67,789	* 67,789	* 67,789	* 67,789	* 67,789	67,184
		8 3/4							* 79,544	* 79,544	* 79,544	76,706	72,102	67,184
		9							88,582	83,992	80,991	76,706	72,102	67,184
		9 1/4							88,582	83,992	80,991	76,706	72,102	67,184
		9 1/2							88,582	83,992	80,991	76,706	72,102	67,184
API	NC70	9							* 75,781	* 75,781	* 75,781	* 75,781	* 75,781	* 75,781
		9 1/4							* 88,802	* 88,802	* 88,802	* 88,802	* 88,802	* 88,802
		9 1/2							* 102,354	* 102,354	* 102,354	101,107	96,214	90,984
		9 3/4							113,710	108,841	105,657	101,107	96,214	90,984
		10							113,710	108,841	105,657	101,107	96,214	90,984

Connection			Make-up Torque [a,b,c,d] (ft-lb)											
Size	Type	OD (in.)	Bore of Drill Collar (in.)											
			1	**1 1/4**	**1 1/2**	**1 3/4**	**2**	**2 1/4**	**2 1/2**	**2 13/16**	**3**	**3 1/4**	**3 1/2**	**3 3/4**
		10 1/4							113,710	108,841	105,657	101,107	96,214	90,984
API	NC77	10							* 108,194	* 108,194	* 108,194	* 108,194	* 108,194	* 108,194
		10 1/4							* 124,051	* 124,051	* 124,051	* 124,051	* 124,051	* 124,051
		10 1/2							* 140,491	* 140,491	* 140,491	140,488	135,119	129,375
		10 3/4							154,297	148,965	145,476	140,488	135,119	129,375
		11							154,297	148,965	145,476	140,488	135,119	129,375
7	H90	8							* 53,454	* 53,454	* 53,454	* 53,454	* 53,454	* 53,454
		8 1/4							* 63,738	* 63,738	* 63,738	* 63,738	60,971	56,382
		8 1/2							* 74,478	72,066	69,265	65,267	60,971	56,382
7 5/8	Regular	8 1/2							* 60,402	* 60,402	* 60,402	* 60,402	* 60,402	* 60,402
		8 3/4							* 72,169	* 72,169	* 72,169	* 72,169	* 72,169	* 72,169
7 5/8	Regular	9							* 84,442	* 84,442	* 84,442	84,221	79,536	74,529
		9 1/4							96,301	91,633	88,580	84,221	79,536	74,529
		9 1/2							96,301	91,633	88,580	84,221	79,536	74,529
7 5/8	H90	9							* 73,017	* 73,017	* 73,017	* 73,017	* 73,017	* 73,017
		9 1/4							* 86,006	* 86,006	* 86,006	* 86,006	* 86,006	* 86,006
		9 1/2							* 99,508	* 99,508	* 99,508	* 99,508	* 99,508	96,285
8 5/8	Regular	10							* 109,345	* 109,345	* 109,345	* 109,345	* 109,345	* 109,345
		10 1/4							* 125,263	* 125,263	* 125,263	* 125,263	* 125,263	125,034
		10 1/2							* 141,767	* 141,767	141,134	136,146	130,777	125,034
8 5/8	H90	10 1/4							* 113,482	* 113,482	* 113,482	* 113,482	* 113,482	* 113,482
		10 1/2							* 130,063	* 130,063	* 130,063	* 130,063	* 130,063	* 130,063
7	H90 (with low torque face)	8 3/4								* 68,061	* 68,061	67,257	62,845	58,131
		9								74,235	71,361	67,257	62,845	58,131
7 5/8	Regular (with low torque face)	9 1/4									* 73,099	* 73,099	* 73,099	* 73,099
		9 1/2									* 86,463	* 86,463	82,457	77,289
		9 3/4									91,789	87,292	82,457	77,289
		10									91,789	87,292	82,457	77,289
7 5/8	H90 (with low torque face)	9 3/4								* 91,667	* 91,667	* 91,667	* 91,667	* 91,667
		10								* 106,260	* 106,260	* 106,260	104,171	98,804
		10 1/4								117,112	113,851	109,188	104,171	98,804
		10 1/2								117,112	113,851	109,188	104,171	98,804

Connection			**Make-up Torque** [a,b,c,d] (ft-lb)											
Size	**Type**	**OD** (in.)	**Bore of Drill Collar** (in.)											
			1	**$1^{1}/_{4}$**	**$1^{1}/_{2}$**	**$1^{3}/_{4}$**	**2**	**$2^{1}/_{4}$**	**$2^{1}/_{2}$**	**$2^{13}/_{16}$**	**3**	**$3^{1}/_{4}$**	**$3^{1}/_{2}$**	**$3^{3}/_{4}$**
$8^{5}/_{8}$	Regular (with low torque face)	$10^{3}/_{4}$									* 112,883	* 112,883	* 112,883	* 112,883
		11									* 130,672	* 130,672	* 130,672	* 130,672
		$11^{1}/_{4}$									147,616	142,430	136,846	130,871
$8^{5}/_{8}$	H90 (with low torque face)	$10^{3}/_{4}$									* 92,960	* 92,960	* 92,960	* 92,960
		11									* 110,781	* 110,781	* 110,781	* 110,781
		$11^{1}/_{4}$									* 129,203	* 129,203	* 129,203	* 129,203

[a] Torque values marked with an asterisk (*) indicate that the weaker member for the corresponding outside diameter (OD) and bore is the box; for all other torque values, the weaker member is the pin.

[b] Normal torque range is tabulated value plus 10 %; higher torque values may be used under extreme conditions.

[c] Torque values apply to all interchangeable connections defined in 11.2, when used with the same drill collar outside diameter and bore; i.e. $2^{3}/_{8}$ API IF, API NC26, and $2^{7}/_{8}$ Slim Hole connections used with $3^{1}/_{2}$ × $1^{1}/_{4}$ drill collars all have the same minimum make-up torque of 4600 ft-lb, and the box is the weaker member.

[d] Stress-relief features are disregarded for make-up torque.

[e] Make-up torque for $2^{7}/_{8}$ PAC connection is based on 62,500 psi stress; previously it was based on 87,500 psi stress because initially $2^{7}/_{8}$ PAC collars were made with 150,000 psi minimum yield material.

NOTE All calculated values are based on the equations provided in Annex G.

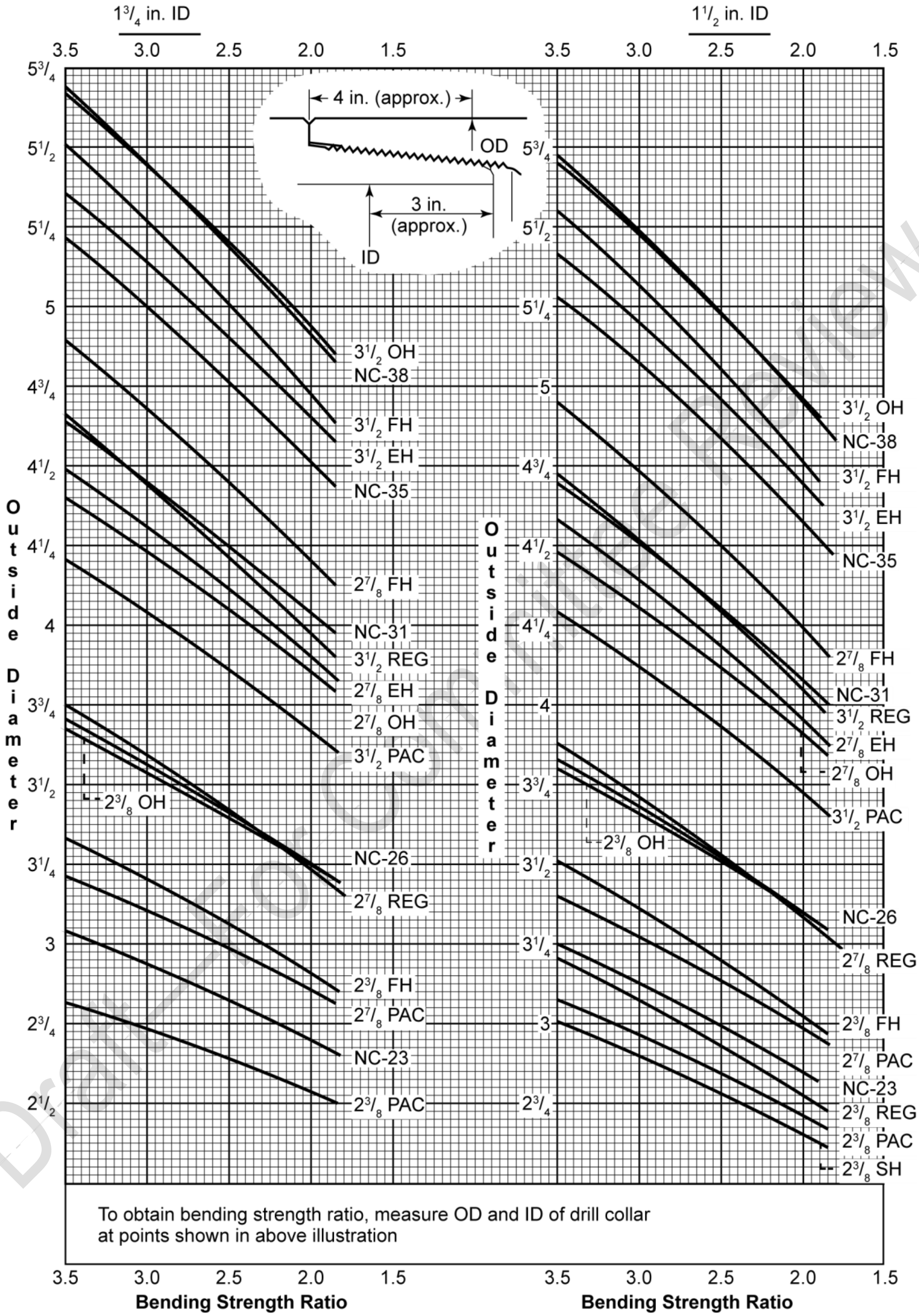


Figure B.1—Drill Collar Bending Strength Ratios, 1$^1/_2$-in. and 1$^3/_4$-in. ID

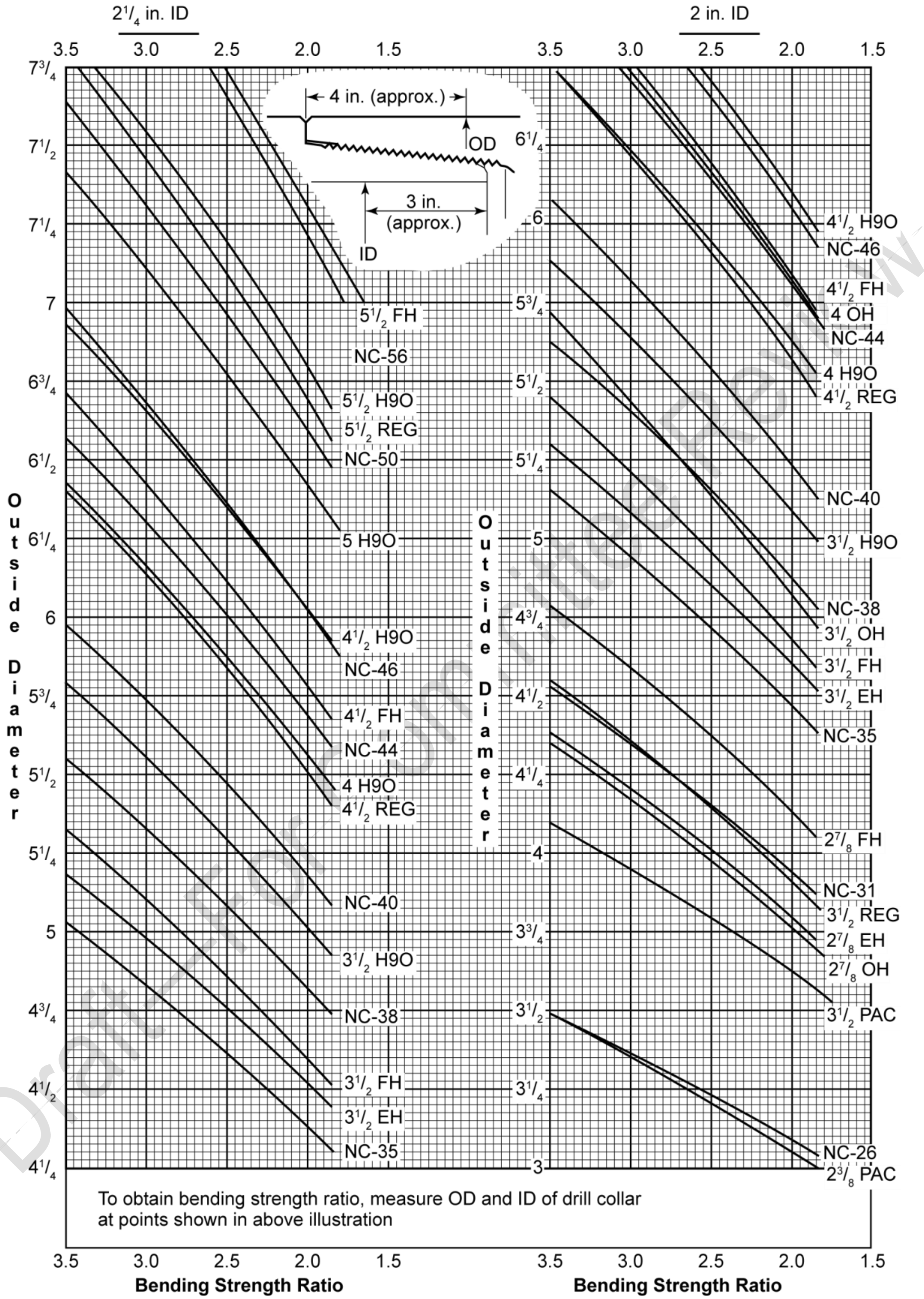


Figure B.2—Drill Collar Bending Strength Ratios, 2-in. and 2¹/₄-in. ID

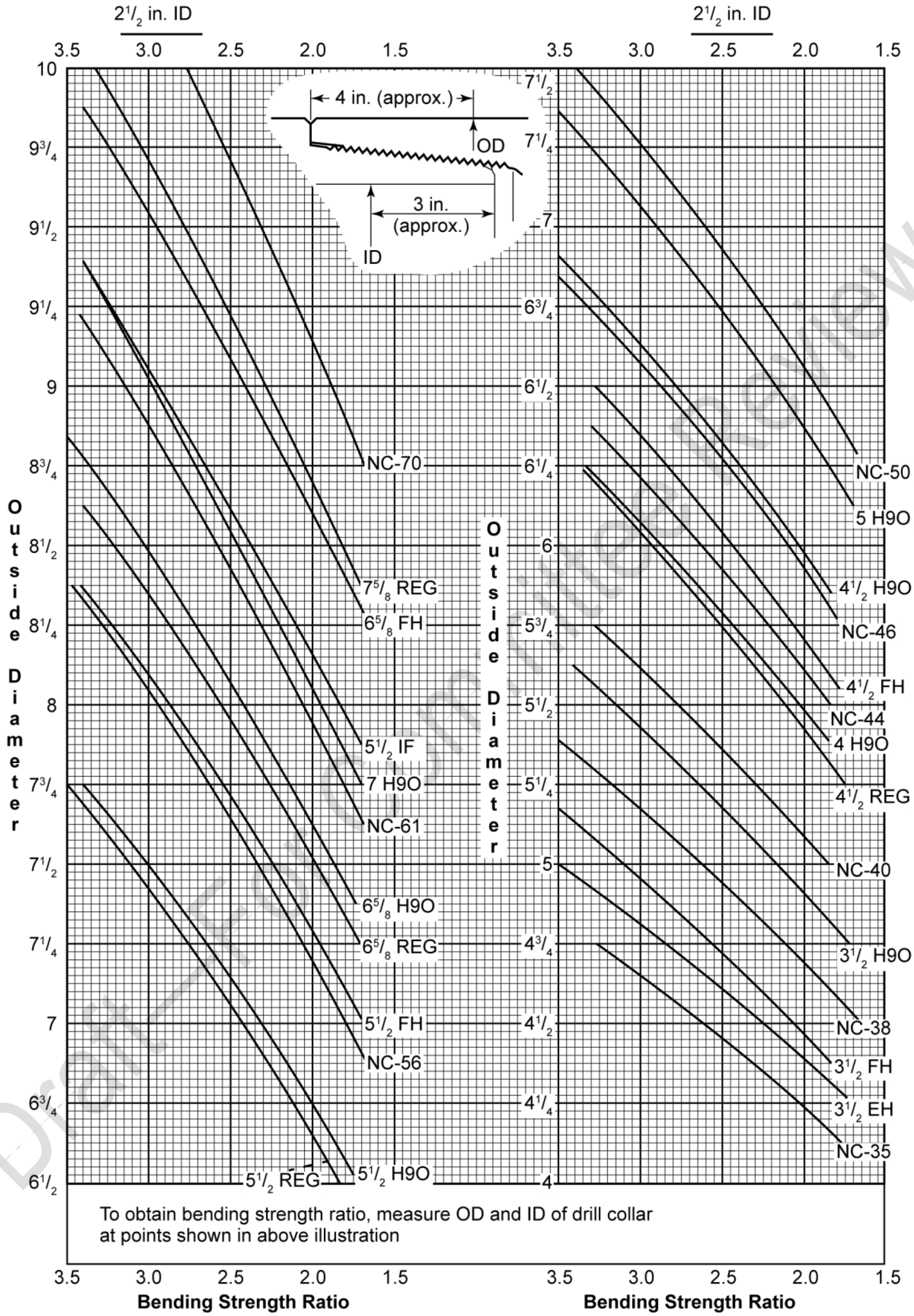


Figure B.3—Drill Collar Bending Strength Ratios, 2½-in. ID

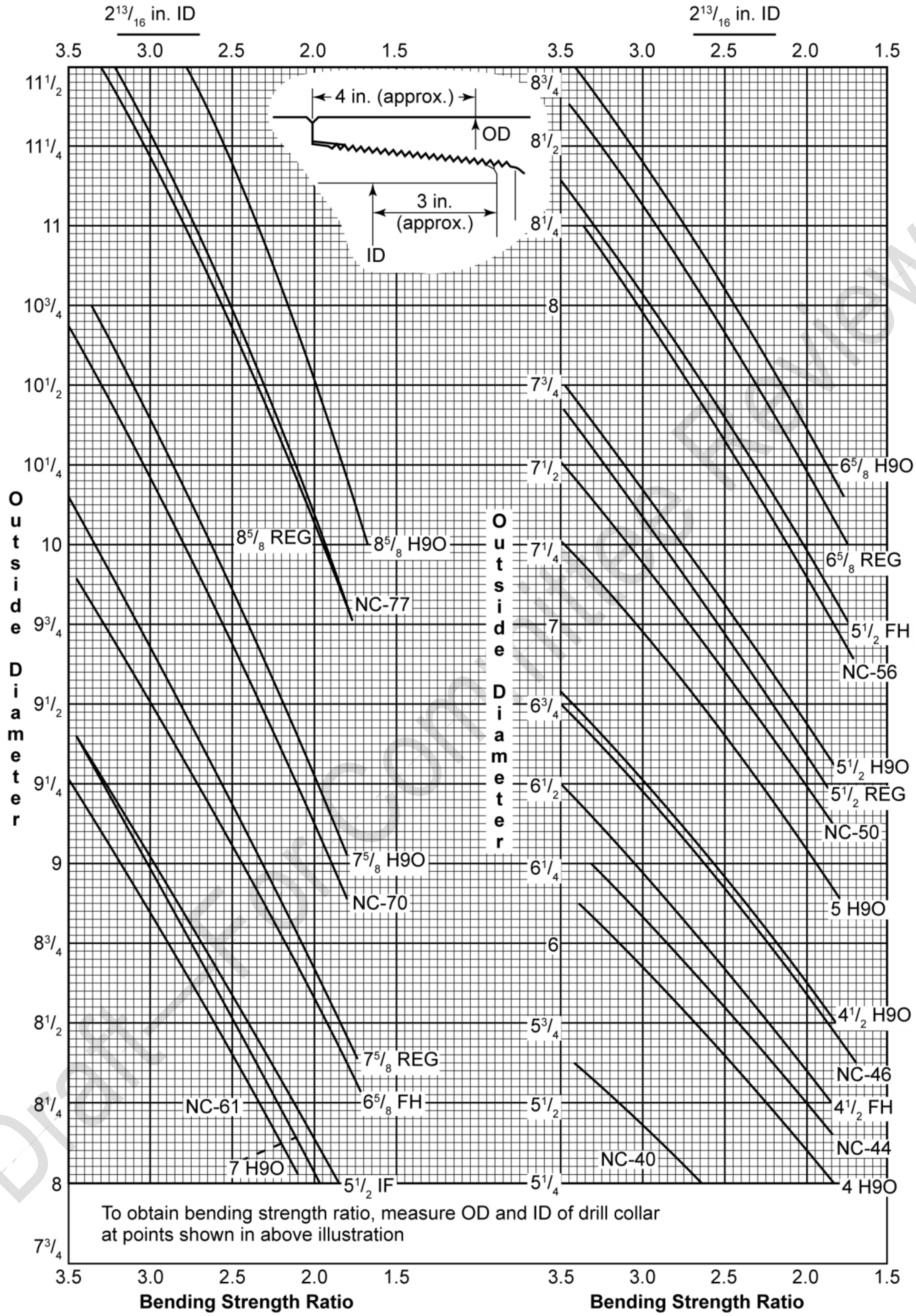


Figure B.4—Drill Collar Bending Strength Ratios, 2 13/16-in. ID

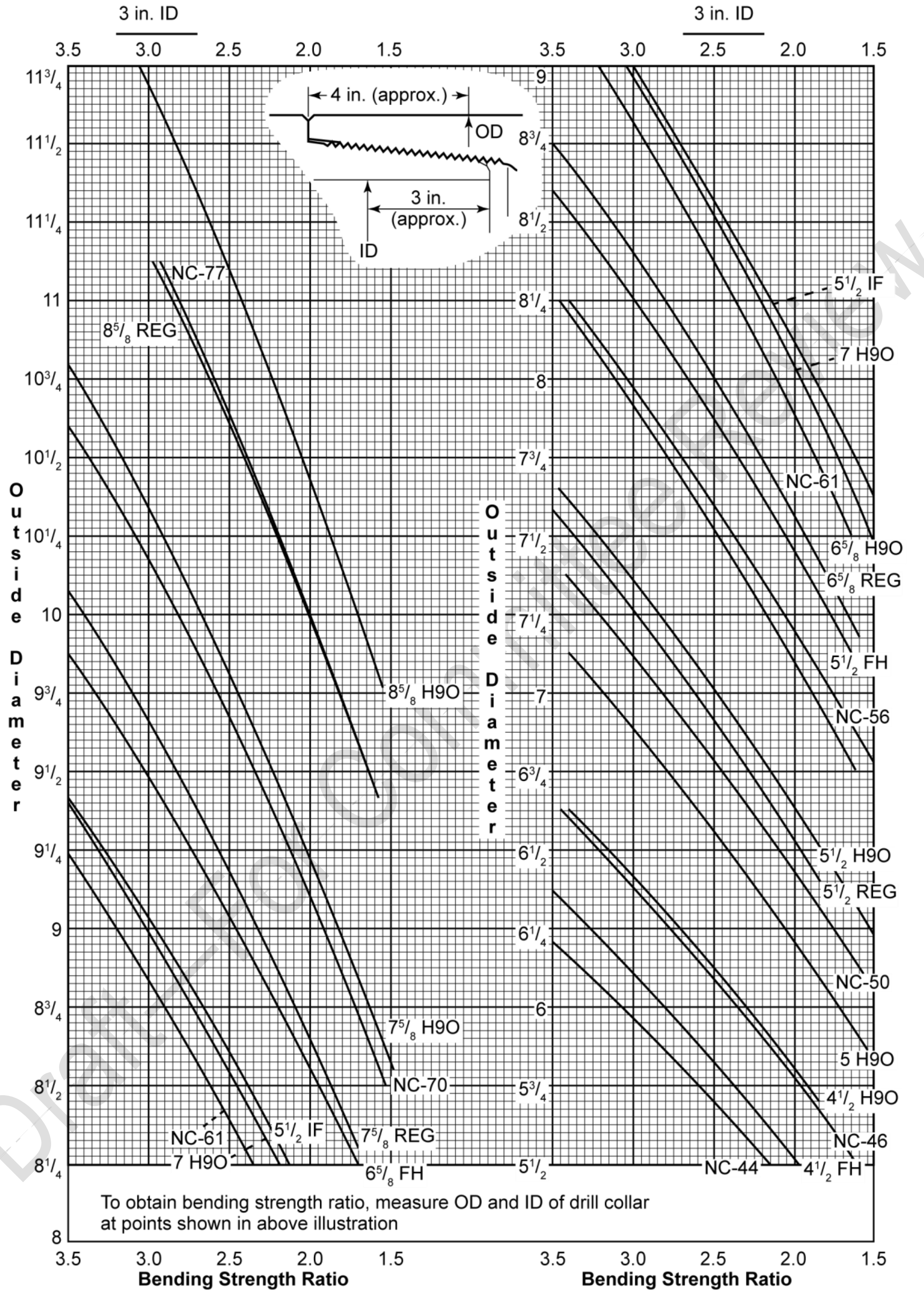


Figure B.5—Drill Collar Bending Strength Ratios, 3-in. ID

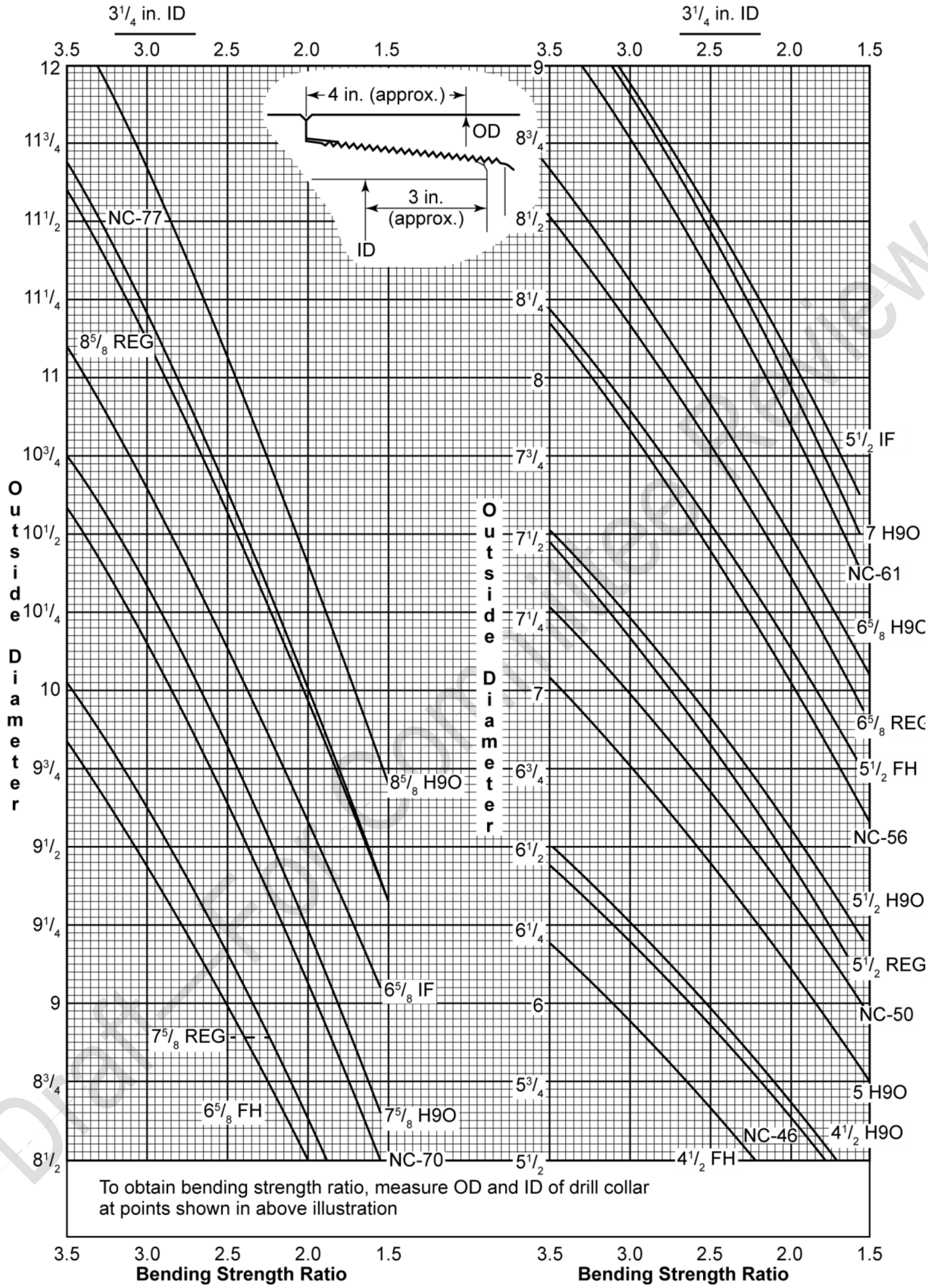


Figure B.6—Drill Collar Bending Strength Ratios, 3 1/4-in. ID

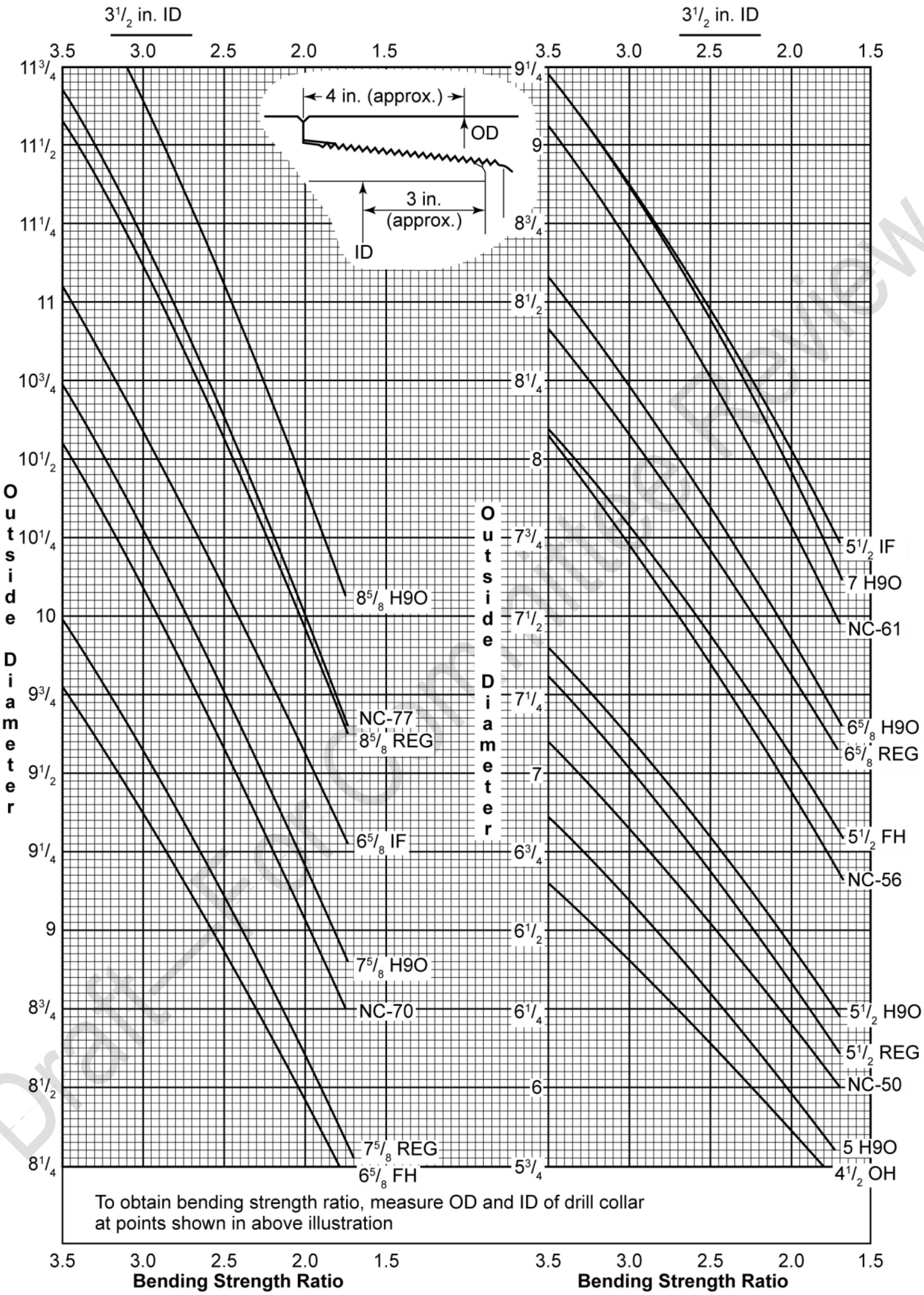


Figure B.7—Drill Collar Bending Strength Ratios, 3 1/2-in. ID

Annex C
(informative)

Properties of Heavy Weight Drill Pipe

Table C.1—New Heavy Weight Drill Pipe Properties

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Assembly									**Tool Joint**			**Tube**	
Size	**RSC Ttype**	**Tube OD** (in.)	**Box OD** (in.)	**Center Upset Diameter** (in.)	**Tube ID** (in.)	**Pin ID** (in.)	**Approx Adjusted Weight of Drill Pipe** [a] (lb/ft)	**Approx Avg Polar Moment of Inertia** [b] (in.^{4})	**Yield Tension** [c] (lbf)	**Yield Torsion** [d] (ft-lbf)	**Make-up Torque** [e] (ft-lbf)	**Yield Tension** [f] (lbf)	**Yield Torsion** [g] (ft-lbf)
$3^{1}/_{2}$	NC38	3.5	$4^{3}/_{4}$	4	2.06	$2^{1}/_{16}$	25.55	7.39	748,951	16,743	9513	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	$4^{3}/_{4}$	4	2.06	$2^{3}/_{16}$	25.37	7.38	700,354	16,743	9513	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	$4^{3}/_{4}$	4	2.25	$2^{1}/_{4}$	23.39	6.98	675,043	16,743	9513	276,097	16,920
$3^{1}/_{2}$	NC38	3.5	$4^{3}/_{4}$	4	2.25	$2^{3}/_{8}$	23.19	6.98	622,397	16,743	9513	276,097	16,920
$3^{1}/_{2}$	NC38	3.5	$4^{7}/_{8}$	4	2.06	$2^{1}/_{16}$	25.96	7.42	748,951	20,133	11,439	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	$4^{7}/_{8}$	4	2.06	$2^{3}/_{16}$	25.78	7.41	700,354	20,133	11,439	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	$4^{7}/_{8}$	4	2.25	$2^{1}/_{4}$	23.80	7.01	675,043	20,133	11,439	276,097	16,920
$3^{1}/_{2}$	NC38	3.5	$4^{7}/_{8}$	4	2.25	$2^{3}/_{8}$	23.61	7.01	622,397	19,319	10,977	276,097	16,920
$3^{1}/_{2}$	NC38	3.5	5	4	2.06	$2^{1}/_{16}$	26.39	7.44	748,951	23,516	13,361	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	5	4	2.06	$2^{3}/_{16}$	26.21	7.44	700,354	21,897	12,442	313,051	18,256
$3^{1}/_{2}$	NC38	3.5	5	4	2.25	$2^{1}/_{4}$	24.23	7.04	675,043	21,058	11,965	276,097	16,920
$3^{1}/_{2}$	NC38	3.5	5	4	2.25	$2^{3}/_{8}$	24.03	7.03	622,397	19,319	10,977	276,097	16,920
4	NC40	4	$5^{1}/_{4}$	4.5	2.50	$2^{1}/_{2}$	30.75	12.06	740,391	24,406	13,867	382,740	26,264
4	NC40	4	$5^{1}/_{4}$	4.5	2.56	$2^{9}/_{16}$	29.90	11.85	711,706	23,404	13,298	368,397	25,650
4	NC40	4	$5^{1}/_{4}$	4.5	2.56	$2^{11}/_{16}$	29.68	11.84	652,310	21,340	12,125	368,397	25,650
$4^{1}/_{2}$	NC46	4.5	$6^{1}/_{4}$	5	2.69	$2^{11}/_{16}$	42.08	20.01	1,055,213	39,469	22,425	520,936	39,092
$4^{1}/_{2}$	NC46	4.5	$6^{1}/_{4}$	5	2.75	$2^{3}/_{4}$	41.18	19.74	1,024,503	38,252	21,734	505,581	38,423

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Assembly									Tool Joint			Tube	
Size	**RSC Ttype**	**Tube OD** (in.)	**Box OD** (in.)	**Center Upset Diameter** (in.)	**Tube ID** (in.)	**Pin ID** (in.)	**Approx Adjusted Weight of Drill Pipe** [a] (lb/ft)	**Approx Avg Polar Moment of Inertia** [b] ($in.^4$)	**Yield Tension** [c] (lbf)	**Yield Torsion** [d] (ft-lbf)	**Make-up Torque** [e] (ft-lbf)	**Yield Tension** [f] (lbf)	**Yield Torsion** [g] (ft-lbf)
4 1/2	NC46	4.5	6 1/4	5	2.75	2 7/8	40.93	19.73	961,058	35,747	20,311	505,581	38,423
4 1/2	NC46	4.5	6 1/4	5	2.81	2 13/16	40.25	19.45	993,118	37,011	21,029	489,888	37,710
5	NC50	5	6 5/8	5.5	3.00	3	50.13	30.12	1,232,061	49,897	28,351	644,621	53,765
5	NC50	5	6 5/8	5.5	3.00	3 1/16	50.00	30.12	1,197,976	48,437	27,521	644,621	53,765
5 1/2	5 1/2 FH	5.5	7	6	3.25	3 1/4	60.02	44.04	1,416,854	50,829	31,768	799,860	72,653
5 1/2	5 1/2 FH	5.5	7	6	3.38	3 3/8	57.81	43.10	1,349,359	50,829	31,768	762,737	70,722
5 1/2	5 1/2 FH	5.5	7	6	3.38	3 1/2	57.51	43.08	1,279,409	50,829	31,768	762,737	70,722
5 1/2	5 1/2 FH	5.5	7	6	3.88	3 7/8	48.13	38.08	1,054,835	46,405	29,003	600,749	60,657
5 1/2	5 1/2 FH	5.5	7	6	4.00	4	45.50	36.47	975,068	42,717	26,698	556,877	57,472
5 1/2	5 1/2 FH	5.5	7 1/4	6	3.25	3 1/4	61.24	44.35	1,416,854	63,366	39,604	799,860	72,653
5 1/2	5 1/2 FH	5.5	7 1/4	6	3.38	3 3/8	59.03	43.39	1,349,359	60,176	37,610	762,737	70,722
5 1/2	5 1/2 FH	5.5	7 1/4	6	3.38	3 1/2	58.74	43.38	1,279,409	56,884	35,552	762,737	70,722
5 1/2	5 1/2 FH	5.5	7 1/4	6	3.88	3 7/8	49.35	38.33	1,054,835	46,405	29,003	600,749	60,657
5 1/2	5 1/2 FH	5.5	7 1/4	6	4.00	4	46.73	36.71	975,068	42,717	26,698	556,877	57,472
5 1/2	5 1/2 FH	5.5	7 1/2	6	3.25	3 1/4	62.51	44.61	1,416,854	63,366	39,604	799,860	72,653
5 1/2	5 1/2 FH	5.5	7 1/2	6	3.38	3 3/8	60.30	43.64	1,349,359	60,176	37,610	762,737	70,722
5 1/2	5 1/2 FH	5.5	7 1/2	6	3.38	3 1/2	60.01	43.63	1,279,409	56,884	35,552	762,737	70,722
5 1/2	5 1/2 FH	5.5	7 1/2	6	3.88	3 7/8	50.62	38.54	1,054,835	46,405	29,003	600,749	60,657
5 1/2	5 1/2 FH	5.5	7 1/2	6	4.00	4	48.00	36.91	975,068	42,717	26,698	556,877	57,472
5 7/8	5 1/2 FH	5.875	7	6	4.00	4	54.68	49.87	975,068	42,717	26,698	740,127	77,945
6 5/8	6 5/8 FH	6.625	8	7.125	4.00	4	82.58	90.20	1,834,105	71,101	44,438	1,143,073	126,138
6 5/8	6 5/8 FH	6.625	8	7.125	4.50	4 1/2	71.23	82.28	1,490,493	71,101	44,438	954,086	112,898
6 5/8	6 5/8 FH	6.625	8	7.125	4.50	4 5/8	70.84	82.21	1,398,454	71,101	44,438	954,086	112,898
6 5/8	6 5/8 FH	6.625	8	7.125	5.00	5	58.55	71.15	1,107,611	55,760	34,850	743,501	94,591
6 5/8	6 5/8 FH	6.625	8 1/4	7.125	4.00	4	83.98	90.89	1,834,105	88,237	55,148	1,143,073	126,138
6 5/8	6 5/8 FH	6.625	8 1/4	7.125	4.50	4 1/2	72.63	82.89	1,490,493	76,161	47,600	954,086	112,898
6 5/8	6 5/8 FH	6.625	8 1/4	7.125	4.50	4 5/8	72.24	82.84	1,398,454	71,223	44,515	954,086	112,898
6 5/8	6 5/8 FH	6.625	8 1/4	7.125	5.00	5	59.95	71.67	1,107,611	55,760	34,850	743,501	94,591

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Assembly									Tool Joint			Tube	
Size	**RSC Ttype**	**Tube OD** (in.)	**Box OD** (in.)	**Center Upset Diameter** (in.)	**Tube ID** (in.)	**Pin ID** (in.)	**Approx Adjusted Weight of Drill Pipe** [a] (lb/ft)	**Approx Avg Polar Moment of Inertia** [b] (in.^{4})	**Yield Tension** [c] (lbf)	**Yield Torsion** [d] (ft-lbf)	**Make-up Torque** [e] (ft-lbf)	**Yield Tension** [f] (lbf)	**Yield Torsion** [g] (ft-lbf)
6 5/8	6 5/8 FH	6.625	8 1/2	7.125	4.00	4	85.42	91.48	1,834,105	94,775	59,234	1,143,073	126,138
6 5/8	6 5/8 FH	6.625	8 1/2	7.125	4.50	4 1/2	74.08	83.42	1,490,493	76,161	47,600	954,086	112,898
6 5/8	6 5/8 FH	6.625	8 1/2	7.125	4.50	4 5/8	73.68	83.38	1,398,454	71,223	44,515	954,086	112,898
6 5/8	6 5/8 FH	6.625	8 1/2	7.125	5.00	5	61.39	72.10	1,107,611	55,760	34,850	743,501	94,591

NOTE Approximate adjusted weight and approximate average polar moment of inertia are calculated using nominal dimensions; all the other properties are calculated based on least material condition.

[a] Approximate Adjusted Weight of HWDP is calculated from Equation (G.21).

[b] Approximate Adjusted Weight of HWDP is calculated from Equation (G.22).

[c] Yield tension of the tool joint is calculated from Equation (G.9).

[d] Yield torsion of the tool joint is calculated from Equation (G.10).

[e] Recommended makeup torque the tool joint is calculated from Equation (G.11).

[f] Tensile strength calculated from Equation (G.7).

[g] Torsional yield strength calculated from Equation (G.8).

Table C.2—Used Heavy Weight Drill Pipe Properties

(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)
Assembly		**Used Tool Joint**					**Used Tube**
Size	**RSC Type**	**Minimum Box OD** [a] (in.)	**Maximum Pin ID** [a] (in.)	**Yield Tension** [b] (lbf)	**Yield Torsion** [c] (ft-lbf)	**Make-up Torque at Minimum Box OD and Maximum Pin ID** [d] (ft-lbf)	**Minimum Center Upset Diameter** [a] (in.)
$3^1/_2$	NC38	$4^{21}/_{32}$	$2^{25}/_{32}$	493,207	15,146	8577	3.75
4	NC40	$5^3/_{32}$	$2^3/_4$	672,009	22,108	12,513	4.25
$4^1/_2$	NC46	$5^{25}/_{32}$	$3^5/_{32}$	876,883	32,695	18,433	4.75
5	NC50	$6^1/_8$	$3^{23}/_{32}$	877,042	35,311	19,797	5.25
$5^1/_2$	$5^1/_2$ FH	$6^{25}/_{32}$	$4^5/_{32}$	947,541	41,740	25,906	5.75
$5^7/_8$	$5^1/_2$ FH	$6^{25}/_{32}$	$4^5/_{32}$	947,541	41,489	25,906	6.125
$6^5/_8$	$6^5/_8$ FH	$7^{25}/_{32}$	$5^1/_{32}$	1,164,228	59,111	36,721	6.875

[a] Used HWDP dimensions are determine following the methods given in G.11.

[b] Yield tension of the tool joint is calculated from Equation (G.9).

[c] Yield torsion of the tool joint is calculated from Equation (G.10).

[d] Recommended make-up torque the tool joint is calculated from Equation (G.11).

Annex D
(informative)

Properties of Kellys

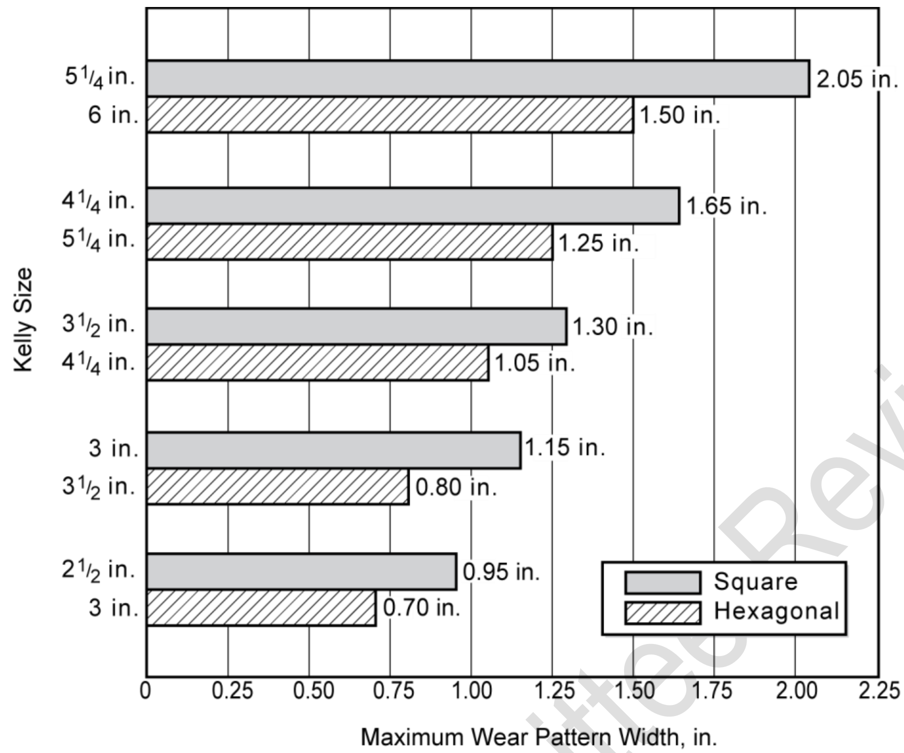
Table D.1—Strength of New Kellys

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Kelly Size and Type (in.)	**Kelly Bore** (in.)	**Lower Pin Connection**		**Minimum Recommended Casing OD** (in.)	**Tensile Yield**		**Torsional Yield**		**Yield in Bending**	**Internal Pressure at Minimum Yield**
		Size and Style	**OD** (in.)		**Lower Pin Connection** (lb)	**Drive Section** (lb)	**Lower Pin Connection** (ft-lb)	**Drive Section** (ft-lb)	**Through Drive Section** (ft-lb)	**Drive Section** (psi)
2 1/2 Square	1 1/4	NC26 (2 3/8 IF)	3 3/8	4 1/2	416,000	444,400	9650	12,300	13,000	29,800
3 Square	1 3/4	NC31 (2 7/8 IF)	4 1/8	5 1/2	535,000	582,500	14,450	19,500	22,300	25,500
3 1/2 Square	2 1/4	NC38 (3 1/2 IF)	4 3/4	6 5/8	724,000	725,200	22,700	28,300	34,200	22,200
4 1/4 Square	2 13/16	NC46 (4IF)	6 1/4	8 5/8	1,054,000	1,047,000	39,350	49,100	60,300	19,500
4 1/4 Square	2 13/16	NC50 (4 1/2 IF)	6 3/8	8 5/8	1,375,200	1,047,000	55,810	49,100	60,300	19,500
5 1/4 Square	3 1/4	5 1/2 FH	7	9 5/8	1,609,000	1,703,400	72,950	99,400	117,000	20,600
3 Hex	1 1/2	NC26 (2 3/8 IF)	3 3/8	4 1/2	356,000	540,500	8300	20,400	20,000	26,700
3 1/2 Hex	1 7/8	NC31 (2 7/8 IF)	4 1/8	5 1/2	495,000	710,000	13,400	31,400	31,200	25,500
4 1/4 Hex	2 1/4	NC38 (3 1/2 IF)	4 3/4	6 5/8	724,000	1,046,600	22,700	56,600	56,000	25,000
5 1/4 Hex	3	NC46 (4 IF)	6 1/4	8 5/8	960,000	1,507,600	35,450	101,900	103,000	20,600
5 1/4 Hex	3 1/4	NC50 (4 1/2 IF)	6 3/8	8 5/8	1,162,000	1,397,100	46,750	95,500	99,300	20,600
6 Hex	3 1/2	5 1/2 FH	7	9 5/8	1,463,000	1,935,500	66,350	149,800	152,500	18,200

NOTE 1 All calculated values are based on the equations provided in Annex G.

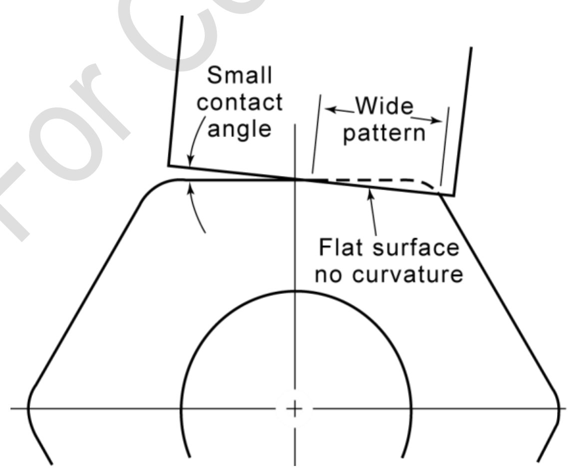
NOTE 2 All values are based on 110,000 psi minimum tensile yield (quenched and tempered) for connections and 90,000 psi minimum tensile yield (normalized and tempered) for the drive section; fully quenched and tempered drive sections will have higher values than those shown.

NOTE 3 Tensile strength of the drive section is calculated from the cross-section area and the minimum tensile yield of the drive section.



NOTE The maximum wear pattern width is the average of the wear pattern widths based on calculations using minimum and maximum clearances and contact angles in Table D.3 and is accurate within 5 %.

Figure D.1—New Kelly (New Drive System), Maximum Wear Pattern Width



NOTE Drive edge will have a wide flat pattern with small contact angle.

Figure D.2—New Kelly (New Drive System), Pattern and Contact Angle

Table D.2—Strength of Remachined Kellys

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Original Kelly Size and Type (in.)	**Remachined Kelly Size and Type** (in.)	**Lower Pin Connection**			**Tensile Yield**		**Torsional Yield**		**Yield in Bending Through Drive Section** (ft-lb)
		Kelly Bore (in.)	**Size and Style**	**OD** (in.)	**Lower Pin Connection** (lb)	**Drive Section** (lb)	**Lower Pin Connection** (ft-lb)	**Drive Section** (ft-lb)	
$4^1/_4$ Square	4 Square	$2^7/_8$	NC50 ($4^1/_2$ IF)	$6^3/_8$	1,344,200	834,400	55,500	36,200	47,800
$4^1/_4$ Square	4 Square	$2^7/_8$	NC46 (4 IF)	$6^1/_4$	1,011,600	834,400	38,300	36,200	47,800
$5^1/_4$ Square	5 Square	$3^3/_4$	$5^1/_2$ IF	$7^3/_8$	1,924,300	1,217,600	92,700	65,000	90,200
$5^1/_4$ Square	5 Square	$3^3/_4$	$5^1/_2$ FH	7	1,356,800	1,217,600	58,900	65,000	90,200
$5^1/_4$ Hex	$4^{27}/_{32}$ Hex	$3^1/_4$	NC46 (4 IF)	$6^1/_4$	809,800	1,077,100	30,600	68,600	74,000
$5^1/_4$ Hex	5 Hex	$3^1/_4$	NC46 (4 IF)	$6^1/_4$	809,800	1,196,800	30,600	78,500	83,300
$5^1/_4$ Hex	5 Hex	$3^1/_2$	NC50 ($4^1/_2$ IF)	$6^3/_8$	999,900	1,077,600	40,800	71,100	78,400
6 Hex	$5^3/_4$ Hex	4	$5^1/_2$ FH	7	1,189,500	1,443,400	51,300	109,100	119,900
6 Hex	$5^3/_4$ Hex	$4^1/_8$	$5^1/_2$ IF	$7^3/_8$	1,669,200	1,371,500	80,400	103,800	116,200

NOTE 1 All calculated values are based on the equations provided in Annex G.

NOTE 2 All values are based on 110,000 psi minimum tensile yield (quenched and tempered) for connections and 90,000 psi minimum tensile yield (normalized and tempered) for the drive section; fully quenched and tempered drive sections will have higher values than those shown.

NOTE 3 Tensile strength of the drive section is calculated from the cross-section area and the minimum tensile yield of the drive section.

Table D.3—Contact Angle between Kelly and Bushing for Development of Maximum Width Wear Pattern

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Hexagon				**Square**			
Kelly Size (in.)	**For Minimum Clearance** (in.)	**Contact Angle** (deg. min.)	**For Maximum Clearance** (in.)	**Contact Angle** (deg. min.)	**For Minimum Clearance** (in.)	**Contact Angle** (deg. min.)	**For Maximum Clearance** (in.)	**Contact Angle** (deg. min.)
$2^1/_2$	—	—	—	—	0.015	6° 10'	0.107	16° 29'
3	0.015	5° 41'	0.060	11° 22'	0.015	5° 39'	0.107	15° 5'
$3^1/_2$	0.015	5° 16'	0.060	10° 32'	0.015	5° 14'	0.107	14° 2'
$4^1/_4$	0.015	4° 48'	0.060	9° 34'	0.015	4° 45'	0.123	13° 36'
$5^1/_4$	0.015	4° 19'	0.060	8° 37'	0.015	4° 17'	0.123	12° 16'
6	0.015	4° 2'	0.060	8° 4'	—	—	—	—

Annex E
(informative)

Properties of Rock Bits

Table E.1—Recommended Minimum Make-up Torques for Fixed Cutter Bits

Connection	**Maximum Pin ID** (in.)	**Bit Sub OD** (in.)	**Minimum Make-up Torque** [a] (ft-lb)
1 API REG	0.75	1.56	185
1 1/2 API REG	1.00	2.00	665
2 3/8 API REG	1	3	1791 *
		3 1/8	2419 *
		3 1/4	3085 *
2 7/8 API REG	1 1/4	3 1/2	3073 *
		3 3/4	4617
		3 7/8	4658
3 1/2 API REG	1 1/2	4 1/8	5171 *
		4 1/4	6306 *
		4 1/2	7660
4 1/2 API REG	2 1/4	5 1/2	12,451 *
		5 3/4	16,476 *
		6	17,551
		6 1/4	17,757
6 5/8 API REG	3 1/4	7 1/2	37,100 *
		7 3/4	37,857
		8	38,193
		8 1/4	38,527
7 5/8 API REG	3 3/4	8 1/2	48,296 *
		8 3/4	57,704 *
		9	59,966
		9 1/4	60,430
		9 1/2	60,895

[a] Torque figures followed by an asterisk (*) indicate that the weaker member for the corresponding outside diameter (OD) and bore is the box; for all other torque values, the weaker member is the pin.

NOTE 1 Preferably, use the manufacturer's recommended make-up torque for fixed cutter bits; if unavailable, the values provided in this table may be considered (these values were retained from prior versions of this standard; torque values are provided for greases with an API friction factor of 1.0).

NOTE 2 Normal torque range is tabulated value plus 10 %; higher torque values may be used under extreme conditions.

Table E.2—Recommended Make-up Torque Ranges for Roller Cone Bits

Connection	Minimum Make-up Torque (ft-lb)	Maximum Make-up Torque (ft-lb)
2 3/8 API REG	3000	3500
2 7/8 API REG	4500	5500
3 1/2 API REG	7000	9000
4 1/2 API REG	12,000	16,000
6 5/8 API REG	28,000	32,000
7 5/8 API REG	34,000	40,000
8 5/8 API REG	40,000	60,000
NOTE Torque values are provided for greases with an API friction factor of 1.0.		

Table E.3—Common Roller Bit Sizes

Size of Bit (in.)	Size of Bit (in.)
3 3/4	9 1/2
3 7/8	9 7/8
4 3/4	10 5/8
5 7/8	11
6	12 1/4
6 1/8	13 1/2
6 1/4	14 3/4
6 1/2	16
6 3/4	17 1/2
7 7/8	20
8 3/8	22
8 1/2	24
8 3/4	26

Table E.4—Common Fixed Cutter Bit Sizes

Size of Bit (in.)	Size of Bit (in.)
3 7/8	8 1/2
4 1/2	8 3/4
4 3/4	9 1/2
5 7/8	9 7/8
6	10 5/8
6 1/8	12 1/4
6 1/4	14 3/4
6 1/2	16
6 3/4	17 1/2
7 7/8	—

Annex F
(informative)

Strength and Design Formulas

Table F.1—Yield Load of Lift Subs

Lift Sub Elevator Recess Diameter (in.)	**Nominal Elevator Diameter** (in.)	**Worst Case Elevator Diameter** (in.)	**Min. Diameter of Lift Shoulder (Tapered or Square)** (in.)	**RSC**	**Max. ID** (in.)	**Yield Load** (lb)
2 3/8	2 11/16	2 11/16	3 1/2	NC26	1.5	143,095
2 7/8	3 13/32	4 11/32	4 1/2	NC31	2	119,382
3 1/2	4 3/32	4 27/32	5	NC38	2.25	132,881
4	4 11/32	5 11/32	6	NC44	2.78	365,077
4 1/2	4 27/32	5 11/32	6 1/4	NC46	2.78	428,368
5	5 11/32	5 11/32	6 1/2	NC50	2.78	563,228
5 1/2	5 29/32	7 1/16	7 1/4	NC50	2.78	210,769
6 5/8	7 1/16	7 1/16	8	6 5/8 REG	2.78	690,549

NOTE All calculated values are based on the equations provided in Annex G.

Annex G
(informative)

Strength and Design Formulas

G.1 Collapse Pressure for Drill Pipe

NOTE See API 5C3 for derivation of equations herein.

The minimum collapse pressures given in Table A.2Table A.2, Table A.3, and Table A.4Table A.4 are calculated from equations in API 5C3. Equations (G.1) through (G.4) are simplified equations that yield similar results. The D/t ratio determines the applicable formula, since each formula is based on a specific D/t ratio range.

For minimum collapse failure in the plastic range with minimum yield stress limitations: the external pressure that generates minimum yield stress on the inside wall of a tube.

$$P_c = 2Y_m \left[\frac{(D/t) - 1}{(D/t)^2} \right] \tag{G.1}$$

Applicable D/t ratios for application of Equation (G.1) are as follows in Table G.1:

Table G.1—*D/t* Ratios for Equation G.1

Grade	*D/t* Ratio
E and SS75	≤ 13.60
X and SS95	≤ 12.85
G and SS105	≤ 12.57
S	≤ 11.92
V	≤ 11.67

For minimum collapse failure in the plastic range:

$$P_c = Y_m\left[\left(\frac{A'}{D/t}\right) - B'\right] - C \tag{G.2}$$

Factors and applicable D/t ratios for application of Equation (G.2) are as follows in Table G.2:

Table G.2— *D/t* Ratios for Equation G.2

Grade	Formula Factors			*D/t* Ratio
	A'	B'	C	
E and SS75	3.054	0.0642	1806	13.60 to 22.91
X and SS95	3.124	0.0743	2404	12.85 to 21.33
G and SS015	3.162	0.0794	2702	12.57 to 20.70
S	3.278	0.0946	3601	11.92 to 19.18

V	3.336	0.1021	4053	11.67 to 18.57

For minimum collapse failure in conversion or transition zone between elastic and plastic range:

$$P_c = Y_m\left[\left(\frac{A}{D/t}\right) - B\right] \quad \text{(G.3)}$$

Factors and applicable D/t ratios for application of Equation (G.3) are as follows in Table G.3:

Table G.3— *D*/*t* Ratios for Equation G.3

Grade	Formula Factors		*D*/*t* Ratio
	A	B	
E and SS75	1.990	0.0418	22.91 to 32.05
X and SS95	2.029	0.0482	21.33 to 28.36
G and SS105	2.053	0.0515	20.70 to 26.89
S	2.133	0.0615	19.18 to 23.44
V	2.174	0.0666	18.57 to 22.11

For minimum collapse failure in the elastic range:

$$P_c = \frac{46.95 \times 10^6}{(D/t)[(D/t) - 1]^2} \quad \text{(G.4)}$$

Applicable D/t ratios for application of Equation (G.4) are as follows in Table G.4:

Table G.4— *D*/*t* Ratios for Equation G.4

Grade	*D*/*t* Ratio
E and SS75	≥ 32.05
X and SS95	≥ 28.36
G and SS105	≥ 26.89
S	≥ 23.44
V	≥ 22.11

where

P_c is the minimum collapse pressure, psi;

D is the nominal outside diameter D_{dp}, in.;

$*t$ is the nominal wall thickness, in.;

Y_m is the material minimum yield strength, psi.

NOTE 1 * Collapse pressures for used drill pipe are determined by adjusting the nominal outside diameter, D, and wall thickness, t, as if the wear is uniform on the outside of the pipe body and the inside diameter remains constant; values of D and t for each class of used drill pipe follow; these values are used in applicable Equation (G.1), (G.2), (G.3), or (G.4), depending on the D/t ratio, to determine collapse pressure.

NOTE 2 Premium Class: t = (0.80) (nominal wall), D = nominal OD – (0.40) (nominal wall)

NOTE 3 Class 2: t = (0.70) (nominal wall), D = nominal OD – (0.60) (nominal wall)

G.2 Internal Pressure

G.2.1 Drill Pipe

Internal pressure for drill pipe can be calculated from Equation (G.5).

$$P_i = \frac{2Y_m t}{D} \tag{G.5}$$

where

P_i is the internal pressure, psi;

Y_m is the material minimum yield strength, psi;

t is the remaining wall thickness of tube, in.;

D is the nominal outside diameter of tube D_{dp}, in.

NOTE 1 Internal pressures for new drill pipe in Table A.2 were determined by using the nominal wall thickness for t in the above equation and multiplying by the factor 0.875 due to permissible wall thickness tolerance of minus $12^1/_2$ %.

NOTE 2 Premium Class: t = (0.80) (nominal wall)

NOTE 3 Class 2: t = (0.70) (nominal wall)

G.2.2 Kellys

Internal pressure for kellys can be calculated from Equation (G.6).

$$P_i = \frac{Y_m[D_{FL}{}^2 - (D_{FL} - 2t)^2]}{\sqrt{3(D_{FL})^4 + (D_{FL} - 2t)^4}} \tag{G.6}$$

where

P_i is the internal pressure, psi;

Y_m is the material minimum yield strength, psi;

D_{FL} is the distance across drive section flats, in.;

t is the minimum wall, in.

NOTE The dimension t is the minimum wall thickness of the drive section and is determined in each case through the use of an ultrasonic thickness gauge or similar device.

G.3 Tensile Strength of Drill Pipe Body

The tensile strength of the drill pipe body can be calculated from Equation (G.7).

$$P = Y_m A, \tag{G.7}$$

where

P is the minimum tensile strength, lb;

Y_m is the material minimum yield strength, psi;

A is the cross-section area, in.^{2}

NOTE 1 Tensile strength for used drill pipe are determined by adjusting the nominal outside diameter, D, and wall thickness, t, as if the wear is uniform on the outside of the pipe body and the inside diameter remains constant.

NOTE 2 Premium Class: t = (0.80) (nominal wall), D = nominal OD – (0.40) (nominal wall)

NOTE 3 Class 2: t = (0.70) (nominal wall), D = nominal OD – (0.60) (nominal wall)

G.4 Torsional Yield Strength of Drill Pipe Body

The pure torsion of the drill pipe body can be calculated by Equation (G.8).

$$Q = \frac{J \cdot Y_m}{6\sqrt{3} \cdot D_{dp}} \tag{G.8}$$

where

Q is the minimum torsional yield strength, ft-lb;

Y_m is the material minimum yield strength, psi;

J is the polar moment of inertia

$= \frac{\pi}{32} (D_{dp}^4 - d_{dp}^4)$ for tubes

D_{dp} is the outside diameter, in.;

D_{dp} is the inside diameter, in.

NOTE 1 Torsional yield strength for used drill pipe are determined by adjusting the nominal outside diameter, D, and wall thickness, t, as if the wear is uniform on the outside of the pipe body and the inside diameter remains constant;

NOTE 2 Premium Class: t = (0.80) (nominal wall), D = nominal OD – (0.40) (nominal wall)

NOTE 3 Class 2: t = (0.70) (nominal wall), D = nominal OD – (0.60) (nominal wall)

G.5 Tensile and Torque Calculations for Rotary Shouldered Connections

The tensile yield strength can be calculated by Equation (G.9). Torque for yielding can be calculated by Equation (G.10). The make-up torque (T_m) can be calculated by Equation (G.11).

$$P = Y_m \cdot \frac{\pi}{4}\left[(C - H + 2 \cdot S_{rs})^2 - ID^2\right] \tag{G.9}$$

$$T_y = \frac{Y_m A}{12}\left(\frac{p}{2\pi} + \frac{R_t f}{\cos\theta} + R_s f\right) \tag{G.10}$$

$$T_m = \frac{SA}{12}\left(\frac{p}{2\pi} + \frac{R_t f}{\cos\theta} + R_s f\right) \tag{G.11}$$

where

P is the tension required to yield, lb;

T_y is the turning moment or torque required to yield, ft-lb;

T_m is the make-up torque, ft-lb;

Y_m is the material minimum yield strength, psi;

S is the recommended make-up stress level, psi; for drill collars and heavy weight drill pipe, it is 56,200 psi for H90 connections and 62,500 psi for other connections; for drill pipe, it is 60 % of the minimum yield strength: 66,000 psi for SS grades and 72,000 psi for all others.

p is the lead of thread, in.;

f is the coefficient of friction on mating surfaces, threads, and shoulders, taken to be 0.08 (API friction factor 1.0)

θ is $^1/_2$ included angle of thread, degrees;

$$R_t = \frac{C + [C - (L_{pc} - .625) \times tpr \times {}^1\!/_{12}\,]}{4};$$

L_{pc} is the length of pin, in.;

$R_s = {}^1/_4\,(OD + Q_c)$, in.;

the maximum value of R_s is limited to the value obtained from the calculated OD where $A_p = A_b$;

$$OD = \sqrt{\frac{4}{\pi} \cdot A + (Q_c - E)^2}$$

A is the cross-section area A_b or A_p, whichever is smaller, in.^{2}; A_p is based on pin connections without stress relief grooves.

$$A_b = \frac{\pi}{4}\,[D^2 - (Q_c - E)^2],$$

$$A_p = \frac{\pi}{4}\,[(C - B)^2 - ID^2]$$

C is the pitch diameter of thread at gauge point, in.;

ID is the inside diameter, in.;

$B = 2(\frac{H}{2} - f_r) + tpr \times {}^1/_8 \times {}^1/_{12}$;

H is the thread height not truncated, in.;

f_r is the root truncation, in.;

tpr is the taper, in./ft;

D is the box outside diameter, in.;

NOTE In calculation of torsional strengths of tool joints, both new and worn, the bevels of the tool joint shoulders are disregarded.

Q_c is the box counterbore, in.;

$E = tpr \times {}^3/_8 \times {}^1/_{12}$.

G.6 Bending Strength Ratio

The bending strength ratio is calculated from Equation (G.12). The effect of stress-relief features is disregarded.

$$BSR = \frac{Z_B}{Z_P} = \frac{\dfrac{OD^4 - b^4}{OD}}{\dfrac{R^4 - ID^4}{R}} \qquad \text{(G.12)}$$

where

BSR is the bending strength ratio;

Z_B is the box section modulus, in.^{3};

Z_P is the pin section modulus, in.^{3};

OD is the outside diameter of pin and box (FiguFigure G.1), in.;

ID is the inside diameter or bore (FiguFigure G.1), in.;

b is the thread root diameter of box threads at end of pin (FiguFigure G.1), in.;

R is the thread root diameter of pin threads $^3/_4$ in. from shoulder of pin (FiguFigure G.1), in.

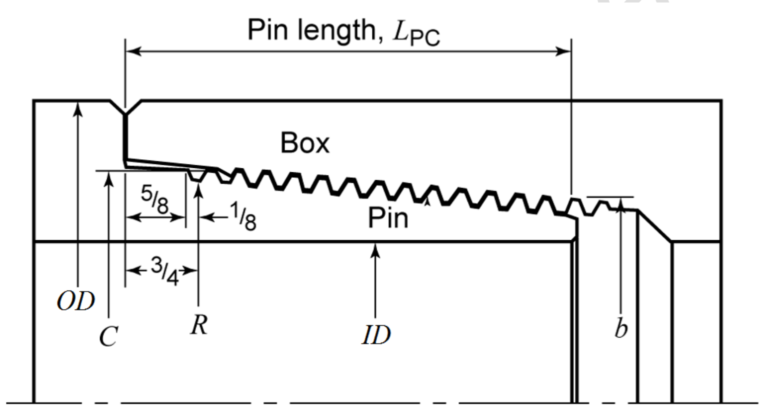


Figure G.1—Rotary Shouldered Connection Location of Dimensions for BSR Calculations

To use Equation (G.12), first calculate:

dedendum, *b*, and *R*

$$dedendum = \frac{H}{2} - f_{rn},$$

where

H is the thread height not truncated, in.;

f_r is the root truncation, in.

$$b = C - \frac{tpr(L_{pc} - 0.625)}{12} + (2 \times dedendum)$$

where

C is the pitch diameter at gauge point, in.,

tpr is the taper, in./ft

$R = C - (2 \times dedendum) - (tpr \times {}^{1}/_{8} \times {}^{1}/_{12})$

An example of the use of Equation (G.12) in determining the bending strength of a typical drill collar connection is as follows.

Determine the bending strength ratio of drill collar NC46-62 ($6^{1}/_{4}$ OD × $2^{13}/_{16}$) ID connection.

OD = 6.25 (API 7-1);

ID = $2^{13}/_{16}$ = 2.8125 (API 7-1);

C = 4.626 (API 7-2);

tpr = 2 (API 7-2);

L_{pc} = 4.5 (API 7-2);

H = 0.216005 (API 7-2);

f_r = 0.038000 (API 7-2).

First calculate *dedendum*, *b*, and *R*

$$dedendum = \frac{H}{2} - f_r = \frac{0.216005}{2} - 0.038000 = 0.0700025$$

$$b = C - \frac{tpr(L_{pc} - 0.625)}{12} + (2 \times dedendum)$$

$$b = 4.626 - \frac{2(4.5 - 0.625)}{12} + (2 \times 0.0700025)$$

$b = 4.120$

$R = C - (2 \times dedendum) - (tpr \times {}^{1}/_{8} \times {}^{1}/_{12})$

$R = 4.626 - (2 \times 0.0700025) - (2 \times {}^{1}/_{8} \times {}^{1}/_{12})$

$R = 4.465$

Substituting these values in Equation (G.12) determines the bending strength ratio as follows:

$$BSR\ (\text{NC46-62}) = \frac{\dfrac{OD^4 - b^4}{OD}}{\dfrac{R^4 - ID^4}{R}}$$

$$= \frac{\dfrac{(6.25)^4 - (4.120)^4}{6.25}}{\dfrac{(4.465)^4 - (2.8125)^4}{4.465}}$$

= 2.64

G.7 Torsional Yield Strength and Bending of Kelly Drive Section

The torsional yield strength of the kelly drive section is calculated by Equation (G.13). The bending strength of the kelly drive section is calculated by Equation (G.14) for square kellys and Equation (G.15) for hex kellys.

$$Y = \frac{0.577 Y_m [0.200(a^3 - b^3)]}{12} \quad \text{(G.13)}$$

$$Y_{BC} = \frac{Y_m \ (0.118\, a^4 - 0.069\, b^4)}{12a} \quad \text{(G.14)}$$

$$Y_{BF} = \frac{Y_m \ (0.104\, a^4 - 0.085\, b^4)}{12a} \quad \text{(G.15)}$$

where

Y_m is the tensile yield, psi;

Y_{BC} is the yield in bending through corners of the square drive section, ft-lb:

Y_{BF} is the yield in bending through the faces of the hexagonal drive section, ft-lb;

a is the distance across flats, in.;

b is the kelly bore, in.

G.8 Used Drill Pipe Dimensional Limits

The criteria for determination of the used drill pipe dimensions limits are:

— Torsional strength of the worn tool joint is at least 80 % of the torsional strength of the pipe.

— Box shoulder of at least $^5/_{32}$ in. to allow for sufficient sealing face, and an eccentric allowance of $^3/_{64}$ in. provided the box shoulder is not less than $^5/_{32}$ in.

To determine the limits:

— Determine the target torsional yield strength by multiplying the used pipe torsional strength listed in Table A.3Table A.3 or Table A.4Table A.4 by 0.8 (80 %). Solve for the box OD and pin ID using Equation (G.10), where $A_p = A_b$, that yields the target torsional yield strength.

— Calculate the minimum box OD needed for sufficient sealing face by adding $^{10}/_{32}$ inch + Q_c

— Minimum OD tool joint is the larger of the two ODs calculated, rounded up to the nearest $^1/_{32}$ in.

— Maximum ID tool joint is the is the calculated pin ID, rounded down to the nearest $^1/_{32}$ in.

— Minimum box shoulder eccentric wear is the larger of $^5/_{32}$ in. or ½ (minimum OD tool joint – Qc) – $^3/_{64}$ rounded to the nearest $^1/_{64}$ in.

G.9 Approximate Weight of Drill Pipe and Drill Pipe Assembly

The plain ends weight of drill pipe in lb/ft is calculated by Equation (G.16(16)

$$w_{pe} = 0.2833 \cdot \tfrac{1}{4} \pi \left(D_{dp}^2 - d_{dp}^2 \right) \cdot 12 \quad (16)$$

The approximate weight of the tool joint plus drill pipe assembly in lb/ft for range 2 pipe is calculated by Equation (G.17)

$$w_{dp} = \frac{Approximate\ Adjusted\ Weight\ of\ Drill\ Pipe \times 29.4 + Approximate\ Weight\ of\ Tool\ Joint}{Tool\ Joint\ \ Adjusted\ Length + 29.4} \quad \text{(G.17)}$$

where

$$Approximate\ Adjusted\ Weight\ of\ Drill\ Pipe = w_{pe} + \frac{e_w}{29.4} \quad \text{(G.18)}$$

e_w is taken from API 5DP or can be calculated by the method given in API 5C3 accounting that e_w is the total mass added on both ends.

$$Approximate\ Adjusted\ Weight\ of\ Drill\ Pipe =$$

$$0.2833 \cdot \tfrac{1}{4}\pi\left[\left(L_{pb}+L_b\right)\left(D^2-d_p^2\right)+\tfrac{1}{6}\left(\cot 18°+\cot 35°\right)\left(D^3-D_{te}^3\right)-\tfrac{1}{2}\left(\cot 18°+\cot 35°\right)\cdot d_p^2\left(D-D_{te}\right)\right] \quad \text{(G.19)}$$

$$Adjusted\ Length\ of\ Tool\ Joints = \frac{\left(L_{pb}+L_b\right)+\tfrac{1}{2}\left(\cot 18°+\cot 35°\right)\left(D-D_{te}\right)}{12} \quad \text{(G.20)}$$

G.10 Properties of Heavy Weight Drill Pipe

Tensile, torsional, and make-up torque is calculated according to G.3, G.4, and G.5. Give the large tolerances on new ODs and IDs, the min. OD and max. ID are used for calculations. Minimum yield strength of 55,000 psi is used for the pipe. Minimum yield strength of 110,000 psi is use for the connection. Depending on the manufacturing method, the pipe or connection may be of higher strength material.

The approximate mass of heavy weight drill pipe is calculated from Equation(G.21) (G.21) using nominal dimensions.

$$Approximate\ Weight\ of\ Heavy\ Weight\ Drill\ Pipe, \frac{lb}{ft} =$$

$$0.2833 \cdot \frac{1}{4}\pi\left[\left(L_{pb}+L_b\right)\left(D^2-d_p^2\right)+L_{cu}\left(D_{cu}^2-d_{dp}^2\right) + \left((12L)-L_{pb}-L_b-L_{cu}\right)\left(D_{dp}^2-d_{dp}^2\right)\right]\frac{1}{L} \quad \text{(G.21)}$$

The approximate area moment of inertia of heavy weight drill pipe is calculated from Equation(G.22) (G.22) using nominal dimensions.

$$Approximate\ Area\ Moment\ of\ Intertia\ of\ Heavy\ Weight\ Drill\ Pipe, in^4 =$$

$$\frac{\pi}{64}\left[\frac{12L-\left(L_b+L_{pb}+L_{cu}\right)}{D_{dp}^4-d_{dp}^4}+\frac{L_b+L_{pb}}{D^4-d_p^4}+\frac{L_{cu}}{D_{cu}^4+d_{dp}^4}\right]^{-1}\cdot 12L \quad \text{(G.22)}$$

where

D is the OD of the tool joint, in.;

d_p is the ID of the tool joint, in.;

D_{dp} is the OD of the drill pipe body, in.;

d_{dp} is the ID of the drill pipe body, in.;

D_{cu} is the center upset diameter, in.;

L_{pb} is the length of the pin tool joint, in.;

L_b is the length of the box tool joint, in.;

L_{cu} is the length of the center upset, in.;

L is the overall length of the pipe, ft.

G.11 Used Heavy Weight Drill Pipe Dimensional Limits

The criteria for determination of the used heavy weight drill pipe dimension limits are:

- Minimum tool joint OD is the new product minimum bevel diameter +1/16 in., rounded up to the nearest 1/32 in.
- Maximum pin ID is the larger of:
  - The new product maximum pin ID, or
  - The pin ID calculated where $A_p = A_b$, rounded down to the nearest 1/32 in. A_b is calculated using the minimum OD tool joint.
- Maximum ID tool joint is the is the calculated pin ID, rounded down to the nearest 1/32 in.
- Minimum center upset diameter is the tube OD + ¼ in.

G.12 Properties of Lift Subs

The lift sub yield load is calculated using Equation(G.21) (G.21).

$$F_{sh} = SY \cdot \frac{\pi}{4} \cdot \ (D_L^2 - d_{st}^2)$$

$$F_{stem} = SY \cdot \frac{\pi}{4} \cdot \ (D_P^2 - d_i^2) \qquad \text{(G.23)}$$

$$F_{pin} = (1 - 0.6) \cdot SY \cdot \frac{\pi}{4} \cdot \ ((C - B)^2 - d_i^2)$$

The lift sub yield load is the minimum of the above.

where

F_{sh} is the yield load of the shoulder

F_{stem} is the yield load of the stem

F_{sh} is the yield load of the pin, reduced to account for makeup to 60 % of yield

D_L, ,D_P , and di are dimensions of the lift sub from API 7-1;

C and B are dimensions of the RSC from API 7-2;

D_{st} elevator worst case (largest) diameter;

Bibliography

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[6] API Technical Report 7CR, *Cold Working Thread Roots with CNC Lathes for Rotary Shouldered Connections*