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Petroleum and natural gas industries — Drilling and production equipment — Drill stem design and operating limits

*Industries du pétrole et du gaz naturel — Étude des garnitures de forage
et de leurs limites d'exploitation*



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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10407 was prepared by the American Petroleum Institute (API) (as RP 7G, 14th edition) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, in parallel with its approval by the ISO member bodies.

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Introduction

International Standard ISO 10407:1993 reproduces the content of API RP 7G, 14th edition, 1990. ISO, in endorsing this API document, recognizes that in certain respects the latter does not comply with all current ISO rules on the presentation and content of an International Standard. Therefore, the relevant technical body, within ISO/TC 67, will review ISO 10407:1993 and reissue it, when practicable, in a form complying with these rules.

This standard is not intended to obviate the need for sound engineering judgement as to when and where this standard should be utilized and users of this standard should be aware that additional or differing requirements may be needed to meet the needs for the particular service intended.

Standards referenced herein may be replaced by other international or national standards that can be shown to meet or exceed the requirements of the referenced standards.

Appendix A forms an integral part of this standard.

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Petroleum and natural gas industries — Drilling and production equipment — Drill stem design and operating limits

1 Scope

This International Standard lays down the properties of drill pipe and tool joints, drill collars, kellys, and establishes principles for the design and use of drill stem and their components.

2 Requirements

Requirements are specified in:

"API Recommended Practice 7G (RP 7G), Fourteenth Edition, August 1, 1990 — *Recommended Practice for Drill Stem Design and Operating Limits*",

which is adopted as ISO 10407.

For the purposes of international standardization, however, modifications shall apply to specific clauses and paragraphs of publication API RP 7G. These modifications are outlined below.

Throughout publication API RP 7G, the conversion of English units shall be made in accordance with ISO 31, in particular for the quantities listed hereafter.

LENGTH	1 inch (in)	= 25,4 mm (exactly)
	1 foot (ft)	= 304,8 mm or 0,304 8 m (exactly)
	1 pound-force per square inch (lbf/in ²)	= 6 894,757 Pa
	NOTE 1 bar = 10 ⁵ Pa	
STRENGTH OR STRESS	1 pound-force per square inch (lbf/in ²)	= 6 894,757 Pa
IMPACT ENERGY	1 foot-pound force (ft·lbf)	= 1,355 818 J
TORQUE	1 foot-pound force (ft·lbf)	= 1,355 818 N·m
TEMPERATURE	The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C):	
	$^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$	
VOLUME	1 cubic foot	= 0,028 316 8 m ³ or 28,316 8 dm ³
	1 gal (US)	= 0,003 785 4 m ³ or 3,785 4 dm ³
	1 barrel (US)	= 0,158 987 m ³ or 158,987 dm ³
MASS	1 pound (lb)	= 0,453 592 37 kg (exactly)
LINEIC MASS	1 pound per foot (lb/ft)	= 1,488 163 9 kg/m

FORCE	1 pound-force (lbf)	= 4,448 222 N
FLOW RATE	1 barrel/day	= 0,158 987 m ³ /day
	1 cubic foot per minute (ft ³ /min)	= 0,028 316 85 m ³ /min or 40,776 192 m ³ /day

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Information given in the POLICY is relevant to the API publication only.

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Pipe manufacturer

The given list of pipe manufacturers may be used on a provisional basis. In the future, the symbols should be registered under an international registration scheme to be established according to Annex N of the ISO/IEC Directives, part 2.

Recommended Practice for Drill Stem Design and Operating Limits

API RECOMMENDED PRACTICE 7G (RP 7G)
FOURTEENTH EDITION, AUGUST 1, 1990

American Petroleum Institute
1220 L Street, Northwest
Washington, DC 20005



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NOTE: This edition supersedes the Thirteenth Edition of this recommended practice dated April 1, 1989. It includes changes adopted at the 1989 Standardization Conference as reported in Circ PS-1887, and as subsequently approved by letter ballot.

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RECOMMENDED PRACTICE FOR DRILL STEM DESIGN AND OPERATING LIMITS

FOREWORD

a. This recommended practice is under the jurisdiction of the API Committee on Standardization of Drilling and Servicing Equipment.

b. The purpose of this recommended practice is to standardize techniques for the procedure of drill stem design and to define the operating limits of the drill stem.

c. References are listed at the end of this publication.

Attention Users of this Publication: Portions of this publication have been changed from the previous edition. The location of changes has been marked with a bar in the margin. In some cases the changes are significant, while in other cases the changes reflect minor editorial adjustments. The bar notations in the margins are provided as an aid to users to identify those parts of this publication that have been changed from the previous edition, but API makes no warranty as to the accuracy of such bar notations.

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SECTION 1 SCOPE

1.1 Coverage. This recommended practice involves not only the selection of drill string members, but also the considerations of hole angle control, drilling fluids, weight and rotary speed, and other operational procedures.

1.2 Sections 2, 3, 4, and 5 provide a step-by-step procedure for selection of drill string members in normal, near-vertical holes. Sections 6, 7, 8, 9, and 12 are

related to operating limitations which may reduce the normal capability of the drill string. Section 10 contains classification system for used drill pipe and used tubing work strings, and identification and inspection procedures for other drill string members. Section 11 contains statements regarding welding on down hole tools. Section 13 covers the classification system for rock (roller) bits.

SECTION 2

PROPERTIES OF DRILL PIPE AND TOOL JOINTS

2.1 This section contains a series of tables designed to present the dimensional, mechanical, and performance properties of new and used drill pipe. Tables are also included listing these properties for tool joints used with new and used drill pipe. Separate tables are included for Torsional and Tensile Data and for Collapse and Internal Pressure Data.

2.2 All drill pipe and tool joint properties tables are included in Section 2.

2.3 Values listed in drill pipe tables are based on accepted standards of the industry and calculated from formulas in Appendix A.

Tool Joint Drift Diameters

2.4 Recommended drift diameters for new drill string assemblies are shown in column 8 of Tables 2.10 and 2.11. Drift bars must be a minimum of four inches long. The drift bar must pass through the upset area but need not penetrate more than twelve inches beyond the base of the elevator shoulder.

Torsional Strength of Tool Joints

2.5 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 torque required to yield a rotary shouldered connection may be obtained from the equation in Par. A.8, Appendix A.

2.6 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

cal torsional strength, assuming all other factors are constant.

2.7 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.

2.8 Minimum OD, box shoulder, and make-up torque values listed in Table 2.12 were determined using the following criteria:

- a. Calculations for recommended tool joint make-up torque are based on the use of a thread compound containing 40-60% by weight of finely powdered metallic zinc applied to all threads and shoulders, and containing not more than 0.3% total active sulfur. Calculations are also based on a tensile stress of 50% of the minimum tensile yield for new joints and 60% for used joints.
- b. In calculation of torsional strengths of tool joints, both new and worn, the bevels of the tool joint shoulders are disregarded.
- c. Premium Class Drill String is based on drill pipe having a minimum wall thickness of 80%.
- d. Class 2 drill string allows drill pipe with a minimum wall thickness of 70%.
- e. 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.

TABLE 2.1
NEW DRILL PIPE DIMENSIONAL DATA

1	2	3	4	5	6	7
Size OD in. D	Nominal Weight Threads & Couplings lb/ft	Plain End Weight ¹ lb/ft	Wall Thickness in.	ID in. d	Section Area Body of Pipe ² sq. in. A	Polar Sectional Modulus ³ cu. in. Z
2%	4.85	4.43	.190	1.995	1.3042	1.321
	6.65	6.26	.280	1.815	1.8429	1.733
2½	6.85	6.16	.217	2.441	1.8120	2.241
	10.40	9.72	.362	2.151	2.8579	3.204
3½	9.50	8.81	.254	2.992	2.5902	3.923
	13.30	12.31	.368	2.764	3.6209	5.144
	15.50	14.63	.449	2.602	4.3037	5.847
4	11.85	10.46	.262	3.476	3.0767	5.400
	14.00	12.93	.330	3.340	3.8048	6.458
	15.70	14.69	.380	3.240	4.3216	7.157
4½	13.75	12.24	.271	3.958	3.6004	7.184
	16.60	14.98	.337	3.826	4.4074	8.543
	20.00	18.69	.430	3.640	5.4981	10.232
	22.82	21.36	.500	3.500	6.2832	11.345
5	16.25	14.87	.296	4.408	4.3743	9.718
	19.50	17.93	.362	4.276	5.2746	11.415
	25.60	24.03	.500	4.000	7.0686	14.491
5½	19.20	16.87	.304	4.892	4.9624	12.221
	21.90	19.81	.361	4.778	5.8282	14.062
	24.70	22.54	.415	4.670	6.6296	15.688
6%	25.20	22.19	.330	5.965	6.5262	19.572

¹lb/ft = 3.3996 x A (col. 6)

²A = 0.7854 (D² - d²)

³Z = 0.19635 $\left(\frac{D^4 - d^4}{D} \right)$

TABLE 2.2
NEW DRILL PIPE TORSIONAL
AND TENSILE DATA

1	2	3	4	5	6	7	8	9	10
Size OD In.	Nom. Weight Thds & Couplings lb.	Torsional Data*				Tensile Data Based on Minimum Values**			
		Torsional Yield Strength, ft-lb				Load at the Minimum Yield Strength, lb;			
		E	95	105	135	E	95	105	135
2 3/8	4.85	4763.	6033.	6668.	8574.	97817.	123902.	136944.	176071.
	6.65	6250.	7917.	8751.	11251.	138214.	175072.	193500.	248786.
2 1/2	6.85	8083.	10238.	11316.	14549.	135902.	172143.	190263.	244624.
	10.40	11554.	14635.	16176.	20798.	214344.	271503.	300082.	385820.
3 1/2	9.50	14146.	17918.	19805.	25463.	194264.	246068.	271970.	349676.
	13.30	18551.	23498.	25972.	33392.	271569.	343988.	380197.	488825.
	15.50	21086.	26708.	29520.	37954.	322775.	408848.	451685.	580995.
4	11.85	19474.	24668.	27264.	35054.	230755.	292290.	323057.	415360.
	14.00	23288.	29498.	32603.	41918.	285359.	361454.	399502.	513646.
	15.70	25810.	32692.	36134.	46458.	324118.	410550.	453765.	583413.
4 1/2	13.75	25907.	32816.	36270.	46633.	270034.	342043.	378047.	486061.
	16.60	30807.	39022.	43130.	55453.	330558.	418707.	462781.	595004.
	20.00	36901.	46741.	51661.	66421.	412358.	522320.	577301.	742244.
	22.82	40912.	51821.	57276.	73641.	471239.	596903.	659735.	948230.
5	16.25	35044.	44389.	49062.	63079.	328073.	415559.	459302.	590531.
	19.50	41167.	52144.	57633.	74100.	395595.	501087.	553833.	712070.
	25.60	52257.	66192.	73159.	94062.	530144.	671515.	742201.	954259.
5 1/2	19.20	44074.	55826.	61703.	79332.	372181.	471429.	521053.	669925.
	21.90	50710.	64233.	70994.	91278.	437116.	553681.	611963.	786809.
	24.70	56574.	71660.	79204.	101833.	497222.	629814.	696111.	894999.
6 3/8	25.20	70580.	89402.	98812.	127044.	489464.	619988.	685250.	881035.

*Based on the shear strength equal to 57.7% of minimum yield strength and nominal wall thickness.

Minimum torsional yield strength calculated from Formula A.15, Par. A.9, Appendix A.

**Minimum tensile strength calculated from Formula A.13, Par. A.7, Appendix A.

TABLE 2.3
NEW DRILL PIPE COLLAPSE AND INTERNAL PRESSURE DATA

1	2	3	4	5	6	7	8	9	10
Size OD	Nom. Weight Thds & Couplings lb.	Collapse Pressure Based On Minimum Values, psi.				Internal Pressure At Minimum Yield Strength, psi.			
in.		E	95	105	135	E	95	105	135
2%	4.85	11040.	13984.	15456.	19035.	10500.	13300.	14700.	18900.
	6.65	15599.	19759.	21839.	28079.	15474.	19600.	21663.	27853.
2½	6.85	10467.	12940.	14020.	17034.	9907.	12548.	13869.	17832.
	10.40	16509.	20911.	23112.	29716.	16526.	20933.	23137.	29747.
3½	9.50	10001.	12077.	13055.	15748.	9525.	12065.	13335.	17145.
	13.30	14113.	17877.	19758.	25404.	13800.	17480.	19320.	24840.
	15.50	16774.	21247.	23484.	30194.	16838.	21328.	23573.	30308.
4	11.85	8381.	9978.	10708.	12618.	8597.	10889.	12036.	15474.
	14.00	11354.	14382.	15896.	20141.	10828.	13716.	15159.	19491.
	15.70	12896.	16335.	18055.	23213.	12469.	15794.	17456.	22444.
4½	13.75	7173.	8412.	8956.	10283.	7904.	10012.	11066.	14228.
	16.60	10392.	12765.	13825.	16773.	9829.	12450.	13761.	17693.
	20.00	12964.	16421.	18149.	23335.	12542.	15886.	17558.	22575.
	22.82	14815.	18765.	20741.	26667.	14583.	18472.	20417.	26250.
5	16.25	6938.	8108.	8616.	9831.	7770.	9842.	10878.	13986.
	19.50	9962.	12026.	12999.	15672.	9503.	12037.	13304.	17105.
	25.60	13500.	17100.	18900.	24300.	13125.	16625.	18375.	23625.
5½	19.20	6039.	6942.	7313.	8093.	7255.	9189.	10156.	13058.
	21.90	8413.	10019.	10753.	12679.	8615.	10912.	12061.	15507.
	24.70	10464.	12933.	14013.	17023.	9903.	12544.	13865.	17826.
6%	25.20	4788.	5321.	5500.	6036.	6538.	8281.	9153.	11768.

NOTE: Calculations are based on formulas in API Bul 5C3.

TABLE 2.4
USED DRILL PIPE
TORSIONAL AND TENSILE DATA
API PREMIUM CLASS

1	2	3	4	5	6	7	8	9	10
Size OD in.	New Wt. Nom. W/ Thds & Couplings lb/ft	^{1,2} Torsional Yield Strength Based On Uniform Wear, ft-lb				² Tensile Data Based On Uniform Wear Load At Minimum Yield Strength, lb,			
		E	95	105	135	E	95	105	135
2%	4.85	3725.	4719.	5215.	6705.	76893.	97398.	107650.	138407.
	6.65	4811.	6093.	6735.	8659.	107616.	136313.	150662.	193709.
2½	6.85	6332.	8020.	8865.	11397.	106946.	135465.	149725.	192503.
	10.40	8858.	11220.	12401.	15945.	166535.	210945.	233149.	299764.
3½	9.50	11094.	14052.	15531.	19968.	152979.	193774.	214171.	275363.
	13.30	14361.	18191.	20106.	25850.	212150.	268723.	297010.	381870.
	15.50	16146.	20452.	22605.	29063.	250620.	317452.	350868.	451115.
4	11.85	15310.	19392.	21433.	27557.	182016.	230554.	254823.	327630.
	14.00	18196.	23048.	25474.	32752.	224182.	283963.	313854.	403527.
	15.70	20067.	25418.	28094.	36120.	253851.	321544.	355391.	456931.
4½	13.75	20403.	25844.	28564.	36725.	213258.	270127.	298561.	383864.
	16.60	24139.	30576.	33795.	43450.	260165.	329542.	364231.	468297.
	20.00	28683.	36332.	40157.	51630.	322916.	409026.	452082.	581248.
	22.82	31587.	40010.	44222.	56856.	367566.	465584.	514593.	661620.
5	16.25	27607.	34969.	38650.	49693.	259155.	328263.	362817.	466479.
	19.50	32285.	40895.	45199.	58113.	311535.	394612.	436150.	560764.
	25.60	40544.	51356.	56762.	72979.	414690.	525274.	580566.	746443.
5½	19.20	34764.	44035.	48670.	62575.	294260.	372730.	411965.	529669.
	21.90	39863.	50494.	55809.	71754.	344780.	436721.	482692.	620604.
	24.70	44320.	56139.	62048.	79776.	391285.	495627.	547799.	704313.
6%	25.20	55766.	70637.	78072.	100379.	387466.	490790.	542452.	697438.

¹Based on the shear strength equal to 57.7% of minimum yield strength.

²Torsional data based on 20% uniform wear on outside diameter and tensile data based on 20% uniform wear on outside diameter.

TABLE 2.5
USED DRILL PIPE COLLAPSE AND INTERNAL PRESSURE DATA
API PREMIUM CLASS

1	2	3	4	5	6	7	8	9	10
OD Size in.	Nominal Weight Thds. & Couplings lb/ft	Collapse Pressure Based On Minimum Values, psi,				Minimum Internal Yield Pressure At Minimum Yield Strength, psi			
		E	95	105	135	E	95	105	135
2 $\frac{3}{8}$	4.85	8522.	10161.	10912.	12891.	9600.	12160.	13440.	17280.
	6.65	13378.	16945.	18729.	24080.	14147.	17920.	19806.	25465.
2 $\frac{7}{8}$	6.85	7640.	9017.	9633.	11186.	9057.	11473.	12680.	16303.
	10.40	14223.	18016.	19912.	25602.	15110.	19139.	21153.	27197.
3 $\frac{1}{2}$	9.50	7074.	8284.	8813.	10093.	8709.	11031.	12192.	15675.
	13.30	12015.	15218.	16820.	21626.	12617.	15982.	17664.	22711.
	15.50	14472.	18331.	20260.	26049.	15394.	19499.	21552.	27710.
4	11.85	5704.	6508.	6827.	7445.	7860.	9956.	11004.	14148.
	14.00	9012.	10795.	11622.	13836.	9900.	12540.	13860.	17820.
	15.70	10914.	13825.	15190.	18593.	11400.	14440.	15960.	20520.
4 $\frac{1}{2}$	13.75	4686.	5190.	5352.	5908.	7227.	9154.	10117.	13008.
	16.60	7525.	8868.	9467.	10964.	8987.	11383.	12581.	16176.
	20.00	10975.	13901.	15350.	18806.	11467.	14524.	16053.	20640.
	22.82	12655.	16030.	17718.	22780.	13333.	16889.	18667.	24000.
5	16.25	4490.	4935.	5067.	5661.	7104.	8998.	9946.	12787.
	19.50	7041.	8241.	8765.	10029.	8688.	11005.	12163.	15638.
	25.60	11458.	14514.	16042.	20510.	12000.	15200.	16800.	21600.
5 $\frac{1}{2}$	19.20	3736.	4130.	4336.	4714.	6633.	8401.	9286.	11939.
	21.90	5730.	6542.	6865.	7496.	7876.	9977.	11027.	14177.
	24.70	7635.	9011.	9626.	11177.	9055.	11469.	12676.	16298.
6 $\frac{3}{8}$	25.20	2931.	3252.	3353.	3429.	5977.	7571.	8368.	10759.

*Data are based on minimum wall of 80% nominal wall. Collapse pressures are based on uniform OD wear. Internal pressures are based on uniform wear and nominal OD.

NOTE: Calculations for Premium Class drill pipe are based on formulas in API Bul 5C3.

TABLE 2.6
USED DRILL PIPE TORSIONAL AND TENSILE DATA
API CLASS 2

1	2	3	4	5	6	7	8	9	10
Size OD in.	New Wt. Nom. W/ Thds. & Couplings lb/ft	^{1,2} Torsional Yield Strength Based On Uniform Wear, ft-lb				² Tensile Data Based on Uniform Wear Load At Minimum Yield Strength, lb.			
		E	95	105	135	E	95	105	135
2 3/8	4.85	3224.	4083.	4513.	5802.	66686.	84469.	93360.	120035.
	6.65	4130.	5232.	5782.	7434.	92871.	117636.	130019.	167167.
2 7/8	6.85	5484.	6946.	7677.	9871.	92801.	117549.	129922.	167043.
	10.40	7591.	9615.	10627.	13663.	143557.	181839.	200980.	258403.
3 1/2	9.50	9612.	12176.	13457.	17302.	132793.	168204.	185910.	239027.
	13.30	12365.	15663.	17312.	22258.	183398.	232304.	256757.	330116.
	15.50	13828.	17515.	19359.	24890.	215967.	273558.	302354.	388741.
4	11.85	13281.	16823.	18594.	23907.	158132.	200301.	221385.	284638.
	14.00	15738.	19935.	22034.	28329.	194363.	246193.	272108.	349852.
	15.70	17315.	21932.	24241.	31166.	219738.	278335.	307633.	395528.
4 1/2	13.75	17715.	22439.	24801.	31887.	185389.	234827.	259545.	333701.
	16.60	20908.	26483.	29271.	37634.	225771.	285977.	316080.	406388.
	20.00	24747.	31346.	34645.	44544.	279502.	354035.	391302.	503103.
	22.82	27161.	34404.	38026.	48890.	317497.	402163.	444496.	571495.
5	16.25	23974.	30368.	33564.	43154.	225316.	285400.	315442.	405568.
	19.50	27976.	35436.	39166.	50356.	270432.	342548.	378605.	486778.
	25.60	34947.	44267.	48926.	62905.	358731.	454392.	502223.	645715.
5 1/2	19.20	30208.	38263.	42291.	54374.	255954.	324208.	358335.	460717.
	21.90	34582.	43804.	48414.	62247.	299533.	379409.	419346.	539160.
	24.70	38383.	48619.	53737.	69090.	339533.	430076.	475347.	611160.
6 3/8	25.20	48497.	61430.	67896.	87295.	337236.	427166.	472131.	607026.

¹Based on the shear strength equal to 57.7% of minimum yield strength.

²Torsional data based on 30% uniform wear on outside diameter and tensile data based on 30% uniform wear on outside diameter.

TABLE 2.7
USED DRILL PIPE COLLAPSE AND INTERNAL PRESSURE DATA
API CLASS 2

1	2	3	4	5	6	7	8	9	10
Size OD in.	Nominal Weight Thds & Couplings lb/ft	¹ Collapse Pressure Based On Minimum Values, psi.				¹ Minimum Internal Yield Pressure At Minimum Yield Strength, psi.			
		E	95	105	135	E	95	105	135
2%	4.85	6852.	7996.	8491.	9664.	8400.	10640.	11760.	15120.
	6.65	12138.	15375.	16993.	21849.	12379.	15680.	17331.	22282.
2%	6.85	6055.	6963.	7335.	8123.	7925.	10039.	11095.	14265.
	10.40	12938.	16388.	18113.	23288.	13221.	16746.	18509.	23798.
3½	9.50	5544.	6301.	6596.	7137.	7620.	9652.	10668.	13716.
	13.30	10858.	13753.	15042.	18396.	11040.	13984.	15456.	19872.
	15.50	13174.	16686.	18443.	23712.	13470.	17062.	18858.	24246.
4	11.85	4311.	4702.	4876.	5436.	6878.	8712.	9629.	12380.
	14.00	7295.	8570.	9134.	10520.	8663.	10973.	12128.	15593.
	15.70	9531.	11468.	12374.	14840.	9975.	12635.	13965.	17955.
4½	13.75	3397.	3845.	4016.	4287.	6323.	8010.	8853.	11382.
	16.60	5951.	6828.	7185.	7923.	7863.	9960.	11009.	14154.
	20.00	9631.	11598.	12520.	15033.	10033.	12709.	14047.	18060.
	22.82	11458.	14514.	16042.	20510.	11667.	14779.	16333.	21000.
5	16.25	3275.	3696.	3850.	4065.	6216.	7874.	8702.	11189.
	19.50	5514.	6262.	6552.	7079.	7602.	9629.	10643.	13684.
	25.60	10338.	12640.	13685.	16587.	10500.	13300.	14700.	18900.
5½	19.20	2835.	3128.	3215.	3265.	5804.	7351.	8125.	10447.
	21.90	4334.	4733.	4899.	5465.	6892.	8730.	9649.	12405.
	24.70	6050.	6957.	7329.	8115.	7923.	10035.	11092.	14261.
6%	25.20	2227.	2343.	2346.	2346.	5230.	6625.	7322.	9414.

¹Data are based on minimum wall of 70% nominal wall. Collapse pressures are based on uniform OD wear. Internal pressures are based on uniform wear and nominal OD.

NOTE: Calculations for Class 2 drill pipe are based on formulas in API Bul 5C3.

EDITORIAL NOTE: Tables 2.8 and 2.9 were deleted in 12th edition of RP 7G and the remaining Tables were *not* renumbered.

TABLE 2.10
MECHANICAL PROPERTIES OF NEW TOOL JOINTS
AND NEW GRADE E DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12
Drill Pipe Data				Tool Joint Data			Drift Diam- eter** in.	Mechanical Properties			
Nom Size in.	Nom. Wt. lb/ft	Approx. Wt.* lb/ft	Type Upset	Conn.	OD in.	ID in.		Tensile Yield, lb		Torsional Yld, ft-lb	
								¹ Pipe	³ Tool Joint	² Pipe	Tool Joint ^f
2 3/8	4.85	5.16	EU	NC26(IF)	3 3/8	1 3/4	1.625	97817.	313681.	4763.	6478.b
		4.89	EU	OH	3 3/8	2	1.807	97817.	206416.	4763.	4525.p
		4.97	EU	SLH90	3 3/4	2	1.850	97817.	202670.	4763.	5127.p
		5.06	EU	WO	3 3/8	2	1.807	97817.	205369.	4763.	4533.p
	6.65	6.92	EU	NC26(IF)	3 3/8	1 3/4	1.625	138214.	313681.	6250.	6478.b
		6.83	EU	OH	3 3/4	1 3/4	1.625	138214.	294774.	6250.	6298.b
		6.71	IU	PAC	2 7/8	1 3/8	1.250	138214.	238634.	6250.	4690.P
		6.73	EU	SLH90	3 3/4	2	1.670	138214.	202670.	6250.	5127.p
	6.85	7.36	EU	NC31(IF)	4 1/8	2 1/8	2.000	135902.	447130.	8083.	11869.p
		6.85	EU	OH	3 3/4	2 7/16	2.253	135902.	223937.	8083.	5589.P
		6.96	EU	SLH90	3 3/8	2 7/16	2.296	135902.	260783.	8083.	7630.p
		7.19	EU	WO	4 1/8	2 7/16	2.253	135902.	289264.	8083.	7511.p
	10.40	10.76	EU	NC31(IF)	4 1/8	2 1/8	1.963	214344.	447130.	11554.	11869.p
		10.51	EU	OH	3 3/8	2 5/32	1.963	214344.	345705.	11554.	8818.P
		10.15	IU	PAC	3 3/8	1 1/2	1.375	214344.	273164.	11554.	5735.P
		10.51	EU	SLH90	3 3/8	2 5/32	2.006	214344.	382551.	11554.	11294.p
		10.99	IU	XH	4 1/4	1 3/8	1.750	214344.	516757.	11554.	13595.p
		10.28	IU	NC26(SH)	3 3/8	1 3/4	1.625	214344.	313681.	11554.	6478.B
3 1/2	9.50	10.44	EU	NC38(IF)	4 3/4	2 11/16	2.563	194264.	587308.	14146.	18107.p
		9.89	EU	OH	4 1/2	3	2.804	194264.	392295.	14146.	11867.p
		10.05	EU	SLH90	4 3/8	3	2.847	194264.	366445.	14146.	12646.p
		10.20	EU	WO	4 3/4	3	2.804	194264.	434198.	14146.	13333.p
	13.30	14.41	EU	H90	5 1/4	2 3/4	2.619	271569.	663633.	18551.	23847.p
		13.77	EU	NC38(IF)	4 3/4	2 11/16	2.457	271569.	587308.	18551.	18107.p
		13.77	EU	OH	4 3/4	2 11/16	2.414	271569.	559806.	18551.	17305.p
		13.40	IU	NC31(SH)	4 3/8	2 1/8	2.000	271569.	447130.	18551.	11869.P
		13.94	EU	XH	4 3/4	2 7/16	2.313	271569.	584542.	18551.	17493.p
	15.50	16.39	EU	NC38(IF)	5	2 9/16	2.414	322775.	649158.	21086.	20326.p
	11.85	13.07	IU	H90	5 1/2	2 13/16	2.688	230755.	914246.	19474.	35441.p
		13.51	EU	NC46(IF)	6	3 1/4	3.125	230755.	901164.	19474.	33625.p
		12.10	EU	OH	5 1/4	3 15/32	3.287	230755.	621623.	19474.	21967.b
		12.91	EU	WO	5 3/4	3 7/16	3.313	230755.	800590.	19474.	29469.p

¹The tensile yield strength of Grade E drill pipe is based on 75,000 psi minimum yield strength.

²The torsional yield strength is based on a shear strength of 57.7% of the minimum yield strength.

³The tensile strength of the tool joint pin is based on 120,000 psi minimum yield and the cross sectional area at the root of the thread 5/8 inch from the shoulder.

*Tool Joint plus drill pipe, for Range 2 steel pipe (See Appendix A for method of calculation).

**See Par. 2.4.

^f: p=pin limited yield. b=box limited yield. P or B indicates that tool joint could not meet 80% of tube torsion yield.

TABLE 2.10 (continued)
MECHANICAL PROPERTIES OF NEW TOOL JOINTS
AND NEW GRADE E DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12		
Drill Pipe Data				Tool Joint Data			Drift Diam- eter** in.	Mechanical Properties					
Nom. Size in.	Nom. Wt. lb/ft.	Approx. Wt.* lb/ft	Type Upset	Conn.	OD in.	ID in.		Tensile	Yield, lb,	Torsional Yld, ft-lb			
								¹ Pipe	³ Tool Joint	² Pipe	Tool Joint ^f		
4	14.00	15.06	IU	NC40(FH)	5¼	2 ¹³ / ₁₆	2.688	285359.	711611.	23288.	23487.p		
		15.41	IU	H90	5½	2 ¹³ / ₁₆	2.688	285359.	914246.	23288.	35441.p		
		15.85	EU	NC46(IF)	6	3¼	3.125	285359.	901164.	23288.	33625.p		
		15.03	EU	OH	5½	3¼	3.125	285359.	760142.	23288.	27279.p		
		14.37	IU	SH	4¾	2 ⁹ / ₁₆	2.438	285359.	525637.	23288.	15581.P		
	15.70	16.81	IU	NC40(FH)	5¼	2 ¹¹ / ₁₆	2.563	324118.	776406.	25810.	25673.p		
		17.07	IU	H90	5½	2 ¹³ / ₁₆	2.688	324118.	914246.	25810.	35441.p		
		17.51	EU	NC46(IF)	6	3¼	3.095	324118.	901164.	25810.	33625.p		
		4½	13.75	15.21	IU	H90	6	3¼	3.125	270034.	938984.	25907.	39021.p
				14.93	EU	NC50(IF)	6¾	3¾	3.625	270034.	939095.	25907.	37676.p
14.06	EU			OH	5¾	3 ³¹ / ₃₂	3.770	270034.	555131.	25907.	20965.p		
14.79	EU			WO	6½	3¾	3.750	270034.	868775.	25907.	34440.p		
16.60	18.14		IEU	FH	6	3	2.875	330558.	976156.	30807.	34780.p		
	17.81	IEU	H90	6	3¼	3.125	330558.	938984.	30807.	39021.p			
	17.98	EU	NC50(IF)	6¾	3¾	3.625	330558.	939095.	30807.	37676.p			
	17.10	EU	OH	5¾	3¾	3.625	330558.	714267.	30807.	27272.p			
	16.79	IEU	NC38(SH)	5	2 ¹¹ / ₁₆	2.563	330558.	587308.	30807.	18346.P			
	18.37	IEU	NC46(XH)	6¼	3¼	3.125	330558.	901164.	30807.	33993.p			
	20.00	21.63	IEU	FH	6	3	2.875	412358.	976156.	36901.	34780.p		
		21.63	IEU	H90	6	3	2.875	412358.	1086246.	36901.	45258.p		
21.62		EU	NC50(IF)	6¾	3¾	3.452	412358.	1025980.	36901.	41235.p			
22.09		IEU	NC46(XH)	6¼	3	2.875	412358.	1048426.	36901.	39659.p			
22.82	24.07	EU	NC50(IF)	6¾	3¾	3.452	471239.	1025980.	40912.	41235.p			
	24.59	IEU	NC46(XH)	6¼	3	2.875	471239.	1048426.	40912.	39659.p			
5	19.50	22.26	IEU	5½FH	7	3¾	3.625	395595.	1448407.	41167.	61352.b		
		20.89	IEU	NC50(XH)	6¾	3¾	3.625	395595.	939095.	41167.	37676.p		
	25.60	28.26	IEU	5½FH	7	3½	3.375	530144.	1619231.	52257.	61352.b		
	26.89	IEU	NC50(XH)	6¾	3½	3.375	530144.	1109920.	52257.	44673.p			
5½	21.90	23.77	IEU	FH	7	4	3.875	437116.	1265802.	50710.	55933.p		
	24.70	26.33	IEU	FH	7	4	3.875	497222.	1265802.	56574.	55933.p		
6¾	25.20	27.3	IEU	FH	8	5	4.875	489470.	1448800.	70580.	74200.p		

¹The tensile yield strength of Grade E drill pipe is based on 75,000 psi minimum yield strength.

²The torsional yield strength is based on a shear strength of 57.7% of the minimum yield strength.

³The tensile strength of the tool joint pin is based on 120,000 psi yield and the cross sectional area at the root of the thread 5/8 inch from the shoulder.

*Tool Joint plus drill pipe, for Range 2 steel pipe (See Appendix A for method of calculation).

**See Par. 2.4.

^f: p=pin limited yield. b=box limited yield. P or B indicates that tool joint could not meet 80% of tube torsion yield.

TABLE 2.11
MECHANICAL PROPERTIES OF NEW TOOL JOINTS
AND NEW HIGH STRENGTH DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12
Drill Pipe Data				Tool Joint Data			Drift Diam- eter** in.	Mechanical Properties			
Nom. Size in.	Nom. Wt. lb/ft	Approx. Wt.* lb/ft	Type Upset and Pipe Grade	Conn.	OD in.	ID in.		Tensile Yield, lb		Torsional Yld., ft-lb	
								Pipe ²	Tool Joint ¹	Pipe ²	Tool Joint ¹
2 3/8	6.65	7.01	EU-X	NC26(IF)	3 3/8	1 3/4	1.625	175072.	313681.	7917.	6478.b
		6.89	EU-X	SLH90	3 3/4	1 13/16	1.670	175072.	270043.	7917.	6884.p
	6.65	7.01	EU-G	NC26(IF)	3 3/8	1 3/4	1.625	193500.	313681.	8751.	6478.B
		6.89	EU-G	SLH90	3 3/4	1 13/16	1.670	193500.	270043.	8751.	6884.P
	10.40	10.96	EU-X	NC31(IF)	4 1/8	2	1.875	271503.	495726.	14635.	13195.p
		10.84	EU-X	SLH90	4	2	1.875	271503.	443756.	14635.	13226.p
2 1/2	10.40	10.96	EU-G	NC31(IF)	4 1/8	2	1.875	300082.	495726.	16176.	13195.p
		10.84	EU-G	SLH90	4	2	1.875	300082.	443756.	16176.	13226.p
	10.40	11.38	EU-S	NC31(IF)	4 3/8	1 5/8	1.500	385820.	623844.	20798.	16944.p
		11.12	EU-S	SLH90	4 1/8	1 5/8	1.500	385820.	571874.	20798.	17226.p
	13.30	14.63	EU-X	H90	5 1/4	2 3/4	2.619	343988.	663633.	23498.	23847.p
		14.41	EU-X	NC38(IF)	5	2 9/16	2.438	343988.	649158.	23498.	20326.p
		14.07	EU-X	SLH90	4 3/4	2 9/16	2.438	343988.	595806.	23498.	20879.p
	13.30	14.49	EU-G	NC38(IF)	5	2 7/16	2.313	380197.	708063.	25972.	22213.p
		14.07	EU-G	SLH90	4 3/4	2 9/16	2.438	380197.	595806.	25972.	20879.p
	13.30	14.69	EU-S	NC38(IF)	5	2 1/8	2.000	488825.	842440.	33392.	26022.B
		14.69	EU-S	SLH90	5	2 1/8	2.000	488825.	789087.	33392.	28078.p
		15.04	EU-S	NC40(4FH)	5 3/8	2 7/16	2.313	488825.	897161.	33392.	29930.p
15.50	16.69	EU-X	NC38(IF)	5	2 7/16	2.313	408848.	708063.	26708.	22213.p	
	15.50	16.88	EU-G	NC38(IF)	5	2 1/8	2.000	451885.	842440.	29520.	26022.b
		16.96	EU-G	NC40(4FH)	5 1/4	2 9/16	2.438	451885.	838257.	29520.	27760.p
15.50	17.56	EU-S	NC40(4FH)	5 1/2	2 1/4	2.125	580995.	979996.	37954.	32943.p	
4	14.00	15.30	IU-X	NC40(FH)	5 1/4	2 11/16	2.563	361454.	776406.	29498.	25673.p
		15.55	IU-X	H90	5 1/2	2 13/16	2.688	361454.	914246.	29498.	35441.p
		16.14	EU-X	NC46(IF)	6	3 3/4	3.125	361454.	901164.	29498.	33625.p
	14.00	15.90	IU-G	NC40(FH)	5 1/2	2 7/16	2.313	399502.	897161.	32603.	30114.p
		15.55	IU-G	H90	5 1/2	2 13/16	2.688	399502.	914246.	32603.	35441.p
		16.14	EU-G	NC46(IF)	6	3 3/4	3.125	399502.	901164.	32603.	33625.p
	14.00	16.18	IU-S	NC40(FH)	5 1/2	2	1.875	513646.	1080135.	41918.	36363.p
		15.55	IU-S	H90	5 1/2	2 13/16	2.688	513646.	914246.	41918.	35441.p
		16.38	EU-S	NC46(IF)	6	3	2.875	513646.	1048426.	41918.	39229.p

¹The torsional yield strength is based on a shear strength of 57.7% of the minimum yield strength.

²The tensile strength of the tool joint pin is based on 120,000 psi yield and the cross sectional area at the root of the thread 5/8 inch from the shoulder.

*Tool Joint plus drill pipe, for Range 2 steel pipe (See Appendix A for method of calculation).

**See Par. 2.4.

f: p=pin limited yield. b=box limited yield. P or B indicates that tool joint could not meet 80% of tube torsion yield.

TABLE 2.11 (continued)
MECHANICAL PROPERTIES OF NEW TOOL JOINTS
AND NEW HIGH STRENGTH DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12	
Drill Pipe Data				Tool Joint Data			Drift Diam- eter** in.	Mechanical Properties				
Nom. Size in.	Nom. Wt. lb/ft	Approx. Wt.* lb/ft	Type Upset and Pipe Grade	Conn.	OD in.	ID in.		Tensile Yield, lb		Torsional Yld., ft-lb		
								Pipe ²	Tool Joint	Pipe ¹	Tool Joint ¹	
4	15.70	17.55	IU-X	NC40(FH)	5½	27/16	2.313	410550.	897161.	32692.	30114.p	
		17.17	IU-X	H90	5½	213/16	2.688	410550.	914246.	32692.	35441.p	
		17.75	EU-X	NC46(IF)	6	3¼	3.125	410550.	901164.	32692.	33625.p	
	15.70	17.55	IU-G	NC40(FH)	5½	27/16	2.313	453765.	897161.	36134.	30114.p	
		17.17	IU-G	H90	5½	213/16	2.688	453765.	914246.	36134.	35441.p	
		17.75	EU-G	NC46(IF)	6	3¼	3.125	453765.	901164.	36134.	33625.p	
	15.70	18.03	EU-S	NC46(IF)	6	3	2.875	583413.	1048426.	46458.	39229.p	
	4½	16.60	18.62	IEU-X	FH	6	3	2.875	418707.	976156.	39022.	34780.p
		18.39	IEU-X	H90	6	3¼	3.125	418707.	938984.	39022.	39021.p	
18.34		EU-X	NC50(IF)	6¾	3¾	3.625	418707.	939095.	39022.	37676.p		
18.88		IEU-X	NC46(XH)	6¼	3	2.875	418707.	1048426.	39022.	39659.p		
16.60	18.62	IEU-G	FH	6	3	2.625	462781.	976156.	43130.	34780.p		
	18.39	IEU-G	H90	6	3	3.125	462781.	938984.	43130.	39021.p		
	18.34	EU-G	NC50(IF)	6¾	3¾	3.625	462781.	939095.	43130.	37676.p		
	18.88	IEU-G	NC46(XH)	6¼	3	2.875	462781.	1048426.	43130.	39659.p		
16.60	19.28	IEU-S	FH	6¼	2½	2.375	595004.	1235337.	55453.	44769.p		
	18.42	IEU-S	H90	6	3	2.875	595004.	938984.	55453.	39021.p		
	18.61	EU-S	NC50(IF)	6¾	3½	3.375	595004.	1109920.	55453.	44673.p		
	19.09	IEU-S	NC46(XH)	6¼	2¾	2.625	595004.	1183908.	55453.	44871.p		
20.00	22.29	IEU-X	FH	6	2½	2.375	522320.	1235337.	46741.	43247.b		
	21.79	IEU-X	H90	6	3¼	3.125	522320.	938984.	46741.	39021.p		
	22.13	EU-X	NC50(IF)	6¾	3½	3.375	522320.	1109920.	46741.	44673.p		
	22.56	IEU-X	NC46(XH)	6¼	2¾	2.625	522320.	1183908.	46741.	44871.p		
20.00	22.29	IEU-G	FH	6	2½	2.375	577301.	1235337.	51661.	43247.b		
	21.90	IEU-G	H90	6	3	2.875	577301.	1086246.	51661.	45258.p		
	22.13	EU-G	NC50(IF)	6¾	3½	3.375	577301.	1109920.	51661.	44673.p		
	22.75	IEU-G	NC46(XH)	6¼	2½	2.375	577301.	1307608.	51661.	49630.p		
20.00	23.22	EU-S	NC50(IF)	6¾	3	2.875	742244.	1416225.	66421.	55708.p		
	22.93	IEU-S	NC46(XH)	6¼	2¾	2.125	742244.	1419527.	66421.	53936.p		
22.82	25.43	IEU-X	FH	6¼	2¼	2.125	596903.	1347256.	51821.	48912.p		
	24.58	EU-X	NC50(IF)	6¾	3½	3.375	596903.	1109920.	51821.	44673.p		
	25.06	IEU-X	NC46(XH)	6¼	2¾	2.625	596903.	1183908.	51821.	44871.p		

(Continued on page 16)

¹The torsional yield strength is based on a shear strength of 57.7% of the minimum yield strength.²The tensile strength of the tool joint pin is based on 120,000 psi yield and the cross sectional area at the root of the thread 5/8 inch from the shoulder.

*Tool Joint plus drill pipe, for Range 2 steel pipe (See Appendix A for method of calculation).

**See Par. 2.4.

†: p=pin limited yield. b=box limited yield. P or B indicates that tool joint could not meet 80% of tube torsion yield.

TABLE 2.11 (continued)
MECHANICAL PROPERTIES OF NEW TOOL JOINTS
AND NEW HIGH STRENGTH DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12
Drill Pipe Data				Tool Joint Data			Drift Diam- eter** in.	Mechanical Properties			
Nom. Size in.	Nom. Wt. lb/ft	Approx. Wt.* lb/ft	Type Upset and Pipe Grade	Conn.	OD in.	ID in.		Tensile Yield, lb		Torsional Yld., ft-lb	
								Pipe ²	Tool Joint	Pipe ¹	Tool Joint
4½	22.82	25.13	EU-G	NC50(IF)	6½	3¼	3.125	659735.	1268963.	57276.	51447.p
		25.25	IEU-G	NC46(XH)	6¼	2½	2.375	659735.	1307608.	57276.	49630.p
		25.83	EU-S	NC50(IF)	6%	2¾	2.625	848230.	1551706.	73641.	62387.b
5	19.50	22.46	IEU-X	5½ FH	7	3¾	3.625	501087.	1448407.	52144.	61352.b
		22.08	IEU-X	H90	6½	3¼	3.125	501087.	1176429.	52144.	51870.p
		21.44	IEU-X	NC50(XH)	6%	3½	3.375	501087.	1109920.	52144.	44673.p
	19.50	22.46	IEU-G	5½ FH	7	3¾	3.625	553833.	1448407.	57633.	61352.b
		22.32	IEU-G	H90	6½	3	2.875	553833.	1323691.	57633.	58469.p
		21.92	IEU-G	NC50(XH)	6½	3¼	3.125	553833.	1268963.	57633.	51447.p
	19.50	23.40	IEU-S	5½ FH	7¼	3½	3.375	712070.	1619231.	74100.	72483.p
		22.60	IEU-S	NC50(XH)	6%	2¾	2.625	712070.	1551706.	74100.	62387.b
	25.60	28.45	IEU-X	5½ FH	7	3½	3.375	671515.	1619231.	66192.	61352.b
		27.86	IEU-X	NC50(XH)	6½	3	2.875	671515.	1416225.	66192.	55708.b
	25.60	29.01	IEU-G	5½ FH	7¼	3½	3.375	742201.	1619231.	73159.	72483.p
	25.60	28.32	IEU-G	NC50(XH)	6%	2¾	2.625	742201.	1551706.	73159.	62387.b
	25.60	29.35	IEU-S	5½ FH	7¼	3¼	3.125	954259.	1778274.	94062.	77151.b
5½	21.90	24.37	IEU-X	FH	7	3¾	3.625	553681.	1448407.	64233.	61352.b
		24.64	IEU-X	H90	7	3½	3.125	553681.	1269528.	64233.	59185.p
	21.90	25.21	IEU-G	FH	7¼	3½	3.375	611963.	1619231.	70994.	72483.p
	21.90	26.33	IEU-S	FH	7½	3	2.875	786809.	1925536.	91278.	87170.p
	24.70	27.76	IEU-X	FH	7¼	3½	3.375	629814.	1619231.	71660.	72483.p
	24.70	27.76	IEU-G	FH	7¼	3½	3.375	696111.	1619231.	79204.	72483.p
	24.70	28.87	IEU-S	FH	7½	3	2.875	894999.	1925536.	101833.	87170.p

¹The torsional yield strength is based on a shear strength of 57.7% of the minimum yield strength.

²The tensile strength of the tool joint pin is based on 120,000 psi yield and the cross sectional area at the root of the thread ⅝ inch from the shoulder.

*Tool Joint plus drill pipe, for Range 2 steel pipe (See Appendix A for method of calculation).

**See Par. 2.4.

f: p=pin limited yield. b=box limited yield. P or B indicates that tool joint could not meet 80% of tube torsion yield.

TABLE 2.12
RECOMMENDED MINIMUM OD ★ AND MAKE-UP TORQUE OF
WELD-ON TYPE TOOL JOINTS BASED ON TORSIONAL STRENGTH
OF BOX AND DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12	
DRILL PIPE			NEW TOOL JOINT DATA				PREMIUM CLASS			CLASS 2		
NOM SIZE	NOM WT.	TYPE UPSET AND GRADE	CONN.	NEW OD	NEW ID	MAKE-UP TORQUE	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT
in.	lb/ft			in.	in.	ft-lb	in.	in.	ft-lb	in.	in.	ft-lb
2%	4.85	EU 75	NC26	3%	1¾	3,438 B	3⅜	⅜ ₆₄	1,945	3⅜ ₃₂	1/32	1,689
	4.85	EU 75	W.O.	3%	2	2,155 P	3⅜ ₁₆	1/16	1,994	3⅜ ₃₂	⅜ ₆₄	1,746
	4.85	EU 75	2% OH	3%	2	2,263 P	3⅜ ₃₂	1/16	1,967	3	⅜ ₆₄	1,723
	4.85	EU 75	2% SL-H90	3¼	2	2,563 P	2⅜ ₁₆	1/16	1,998	2⅜ ₁₆	⅜ ₆₄	1,726
2%	6.65	IU 75	2% PAC	2%	1%	2,344 P	2⅜ ₃₂	9/64	2,455	2⅜ ₃₂	7/64	2,055
	6.65	EU 75	NC26	3%	1¾	3,438 B	3⅜ ₁₆	5/64	2,467	3⅜ ₃₂	1/16	2,204
	6.65	EU 75	2% SL-H90	3¼	2	2,572 P	3⅜ ₃₂	⅜ ₃₂	2,560	2⅜ ₁₆	1/16	1,998
	6.65	EU 75	2% OH	3¼	1¾	3,153 B	3⅜ ₃₂	⅜ ₃₂	2,468	3⅜ ₁₆	5/64	2,216
2%	6.65	EU 95	NC26	3%	1¾	3,438 B	3¼	7/64	3,005	3⅜ ₃₂	⅜ ₃₂	2,734
2%	6.65	EU 105	NC26	3%	1¾	3,438 B	3⅜ ₃₂	1/8	3,279	3¼	7/64	3,005
2%	6.85	EU 75	NC31	4⅞	2⅞	5,935 P	3⅜ ₁₆	5/64	3,154	3⅜ ₃₂	7/64	2,804
	6.85	EU 75	2% WO	4⅞	2⅞ ₁₆	3,598 P	3%	5/64	3,216	3⅜ ₃₂	1/16	2,876
	6.85	EU 75	2% OH	3¾	2⅞ ₁₆	2,463 P	3⅜ ₃₂	⅜ ₃₂	3,242	3⅞ ₁₆	5/64	2,927
	6.85	EU 75	2% SL-H90	3%	2⅞ ₁₆	3,814 P	3½	⅜ ₃₂	3,399	3⅞ ₁₆	1/16	2,666
2%	10.40	EU 75	NC31	4⅞	2⅞	5,935 P	3⅜ ₁₆	9/64	4,597	3%	7/64	3,867
	10.40	EU 75	2% XH	4¼	1⅞	6,681 P	3⅜ ₃₂	9/64	4,379	3⅜ ₃₂	7/64	3,664
	10.40	EU 75	NC26	3%	1¾	3,438 B	3⅜ ₃₂	⅜ ₁₆	4,415	3⅜ ₃₂	5/32	3,839
	10.40	EU 75	2% OH	3%	2⅜ ₃₂	4,064 P	3⅜ ₃₂	5/32	4,542	3⅜ ₃₂	1/8	3,884
	10.40	EU 75	2% SL-H90	3%	2⅜ ₃₂	5,646 P	3⅜ ₃₂	9/64	4,531	3⅜ ₃₂	7/64	3,770
	10.40	EU 75	2% PAC	3%	1½	2,866 P	3%	15/64	3,439	3⅜ ₃₂	7/32	3,841
	10.40	EU 95	NC31	4⅞	2	6,598 P	3⅜ ₃₂	⅜ ₁₆	5,726	3⅜ ₃₂	5/32	4,969
	10.40	EU 95	2% SL-H90	3%	2⅜ ₃₂	5,646 P	3⅜ ₁₆	⅜ ₁₆	5,704	3%	5/32	4,918
2%	10.40	EU 105	NC31	4⅞	2	6,598 P	3⅜ ₁₆	13/64	6,110	3%	11/64	5,345
2%	10.40	EU 135	NC31	4%	1%	8,664 P	4⅜ ₁₆	17/64	7,694	4	15/64	6,893
3½	9.50	EU 75	NC38	4¾	3	6,407 P	4⅜ ₃₂	1/8	5,773	4⅜ ₃₂	⅜ ₃₂	4,882
	9.50	EU 75	NC38	4¾	2⅜ ₁₆	9,096 P	4⅜ ₃₂	1/8	5,803	4⅜ ₃₂	⅜ ₃₂	4,822
	9.50	EU 75	3½ OH	4¾	3	6,014 P	4⅜ ₃₂	1/8	5,340	4¼	7/64	4,868
	9.50	EU 75	3½ SL-H90	4%	3	6,322 P	4⅜ ₁₆	7/64	5,521	4⅜ ₃₂	⅜ ₃₂	5,006
3½	13.30	EU 75	NC38	4¾	2⅜ ₁₆	9,054 P	4½	11/64	7,274	4⅞ ₁₆	9/64	6,268
	13.30	IU 75	NC31	4⅞	2⅞	5,935 P	4	15/64	6,893	3⅜ ₁₆	13/64	6,110
	13.30	EU 75	3½ OH	4¾	2⅜ ₁₆	8,655 P	4⅜ ₃₂	⅜ ₁₆	7,278	4⅜ ₃₂	5/32	6,299
	13.30	EU 75	3½ H90	5¼	2¾	1,299 P	4⅜ ₃₂	1/8	7,064	4½	7/64	6,487
	13.30	EU 95	NC38	5	2⅞ ₁₆	10,163 P	4⅜ ₃₂	7/32	8,822	4⅜ ₃₂	⅜ ₁₆	7,785
	13.30	EU 95	3½ SL-H90	4%	2⅜ ₁₆	9,284 P	4%	13/64	8,742	4⅜ ₁₆	11/64	7,650
3½	13.30	EU 95	3½ H90	5¼	2¾	11,933 P	4%	11/64	8,839	4⅞ ₁₆	9/64	7,646
3½	13.30	EU 105	NC38	5	2⅞ ₁₆	11,106 P	4⅜ ₃₂	1/4	9,879	4⅞ ₃₂	7/32	8,822

TABLE 2.12 (continued)
RECOMMENDED MINIMUM OD * AND MAKE-UP TORQUE OF
WELD-ON TYPE TOOL JOINTS BASED ON TORSIONAL STRENGTH
OF BOX AND DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12	
DRILL PIPE			NEW TOOL JOINT DATA				PREMIUM CLASS			CLASS 2		
NOM SIZE	NOM WT.	TYPE UPSET AND GRADE	CONN.	NEW OD	NEW ID	MAKE-UP TORQUE	MIN BOX SHOULDER MAKE-UP			MIN BOX SHOULDER		
							OD TOOL JOINT	WITH ECCEN- TRIC WEAR	TORQUE. FOR MIN OD TOOL JOINT	OD TOOL JOINT	WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT
in.	lb/ft			in.	in.	ft-lb	in.	in.	ft-lb	in.	in.	ft-lb
3½	13.30	EU 135	NC40	5%	27⁄₁₆	14,965 P	5	9⁄₃₂	12,569	429⁄₃₂	15⁄₆₄	10,768
	13.30	EU 135	NC38	5	2½	13,258 P	413⁄₁₆	21⁄₆₄	12,614	423⁄₃₂	9⁄₃₂	10,957
3½	15.50	EU 75	NC38	5	29⁄₁₆	10,163 P	417⁄₃₂	3⁄₁₆	7,785	415⁄₃₂	5⁄₃₂	6,769
3½	15.50	EU 95	NC38	5	27⁄₁₆	11,106 P	421⁄₃₂	¼	9,879	419⁄₃₂	7⁄₃₂	8,822
3½	15.50	EU 105	NC38	5	2½	13,258 P	423⁄₃₂	9⁄₃₂	10,957	4%	15⁄₆₄	9,348
	15.50	EU 105	NC40	5¼	29⁄₁₆	13,880 P	415⁄₁₆	¼	11,363	427⁄₃₂	13⁄₆₄	9,595
3½	15.50	EU 135	NC40	5½	2¼	16,472 P	53⁄₃₂	21⁄₆₄	14,419	431⁄₃₂	17⁄₆₄	11,963
4	11.85	EU 75	NC46	6	3¼	16,813 P	57⁄₃₂	7⁄₆₄	7,843	55⁄₃₂	5⁄₆₄	6,476
	11.85	EU 75	4 WO	5¾	37⁄₁₆	14,405 P	57⁄₃₂	7⁄₆₄	7,843	55⁄₃₂	5⁄₆₄	6,476
	11.85	EU 75	4 OH	5¼	315⁄₃₂	10,950 P	5	½	7,839	415⁄₁₆	9⁄₆₄	6,571
	11.85	EU 75	4 H90	5½	213⁄₁₆	17,709 P	4%	7⁄₆₄	7,640	427⁄₃₂	3⁄₃₂	6,971
4	14.00	IU 75	NC40	5¼	213⁄₁₆	11,744 P	413⁄₁₆	3⁄₁₆	9,017	4%	5⁄₃₂	7,877
	14.00	EU 75	NC46	6	3¼	16,813 P	59⁄₃₂	9⁄₆₄	7,832	57⁄₃₂	7⁄₆₄	7,843
	14.00	IU 75	4 SH	4%	29⁄₁₆	7,585 P	47⁄₁₆	15⁄₆₄	8,782	4%	13⁄₆₄	7,817
	14.00	EU 75	4 OH	5½	3¼	13,598 P	51⁄₁₆	11⁄₆₄	9,131	5	9⁄₆₄	7,839
	14.00	EU 75	4 H90	5½	213⁄₁₆	17,709 P	415⁄₁₆	9⁄₆₄	8,997	4%	7⁄₆₄	7,640
4	14.00	IU 95	NC40	5¼	211⁄₁₆	12,836 P	415⁄₁₆	¼	11,363	427⁄₃₂	13⁄₆₄	9,595
	14.00	EU 95	NC46	6	3¼	16,813 P	5%	3⁄₁₆	11,363	55⁄₁₆	5⁄₃₂	9,937
	14.00	IU 95	4 H90	5½	213⁄₁₆	17,709 P	51⁄₃₂	3⁄₁₆	11,065	431⁄₃₂	5⁄₃₂	9,685
4	14.00	IU 105	NC40	5½	27⁄₁₆	15,057 P	5	9⁄₃₂	12,569	429⁄₃₂	15⁄₆₄	10,768
	14.00	EU 105	NC46	6	3¼	16,813 P	57⁄₁₆	7⁄₃₂	12,813	511⁄₃₂	11⁄₆₄	10,647
	14.00	IU 105	4 H90	5½	213⁄₁₆	17,709 P	53⁄₃₂	7⁄₃₂	12,497	51⁄₃₂	3⁄₁₆	11,079
	14.00	EU 135	NC46	6	3	19,615 P	59⁄₁₆	9⁄₃₂	15,787	5½	¼	14,288
4	15.70	IU 75	NC40	5¼	211⁄₁₆	12,836 P	4%	7⁄₃₂	10,179	425⁄₃₂	11⁄₆₄	8,444
	15.70	EU 75	NC46	6	3¼	16,813 P	55⁄₁₆	5⁄₃₂	9,937	5¼	½	8,535
	15.70	EU 75	4 H90	5½	213⁄₁₆	17,709 P	431⁄₃₂	5⁄₃₂	9,673	429⁄₃₂	½	8,316
4	15.70	IU 95	NC40	5½	27⁄₁₆	15,057 P	5	9⁄₃₂	12,569	429⁄₃₂	15⁄₆₄	10,791
	15.70	EU 95	NC46	6	3	19,615 P	57⁄₁₆	7⁄₃₂	12,813	511⁄₃₂	11⁄₆₄	10,773
	15.70	IU 95	4 H90	5½	213⁄₁₆	17,709 P	53⁄₃₂	7⁄₃₂	12,497	51⁄₃₂	3⁄₁₆	10,310
4	15.70	EU 105	NC46	6	3	19,615 P	515⁄₃₂	15⁄₆₄	13,547	513⁄₃₂	13⁄₆₄	12,085
	15.70	IU 105	4 H90	5½	213⁄₁₆	17,709 P	55⁄₃₂	¼	13,939	51⁄₁₆	13⁄₆₄	11,785
4	15.70	IU 135	NC46	6	2%	22,485 B	521⁄₃₂	21⁄₆₄	18,083	517⁄₃₂	17⁄₆₄	15,035
	15.70	EU 135	NC46	6	2%	20,932 P	521⁄₃₂	21⁄₆₄	18,083	517⁄₃₂	17⁄₆₄	15,035

TABLE 2.12 (continued)
RECOMMENDED MINIMUM OD* AND MAKE-UP TORQUE OF
WELD-ON TYPE TOOL JOINTS BASED ON TORSIONAL STRENGTH
OF BOX AND DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12	
DRILL PIPE			NEW TOOL JOINT DATA				PREMIUM CLASS			CLASS 2		
NOM SIZE	NOM WT.	TYPE UPSET AND GRADE	CONN.	NEW OD	NEW ID	MAKE-UP TORQUE	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT
in.	lb/ft			in.	in.	ft-lb	in.	in.	ft-lb	in.	in.	ft-lb
4½	16.60	EU 75	4½ FH	6	3	17,390 P	5%	13/64	12,125	59/32	5/32	10,072
	16.60	EU 75	NC46	6¼	3¼	16,997 P	513/32	13/64	12,085	511/32	11/64	10,647
	16.60	EU 75	4½ OH	5%	3¾	13,629 P	57/16	13/64	11,861	5%	11/64	10,375
	16.60	EU 75	NC50	6%	3¾	18,838 P	523/32	19/64	11,591	511/16	9/64	10,773
	16.60	EU 75	4½ H-90	6	3¼	19,497 P	511/32	21/64	12,215	59/32	5/32	10,310
4½	16.60	IEU 95	4½ FH	6	2¾	21,419 P	5½	17/64	14,945	513/32	7/32	12,821
	16.60	IEU 95	NC46	6¼	3¼	16,997 P	517/32	17/64	15,035	57/16	7/32	12,813
	16.60	EU 95	NC50	6%	3¾	18,838 P	527/32	7/32	14,927	525/32	3/16	13,245
	16.60	IEU 95	4½ H-90	6	3	22,616 P	515/32	¼	15,115	5%	13/64	13,102
4½	16.60	IEU 105	4½ FH	6	2¾	19,869 P	59/16	19/64	16,391	515/32	¼	14,321
	16.60	IEU 105	NC46	6¼	3	19,829 P	519/32	19/64	16,546	5½	¼	14,288
	16.60	EU 105	NC50	6%	3¾	18,623 P	529/32	¼	16,634	513/16	13/64	14,083
	16.60	IEU 105	4½ H-90	6	3	22,616 P	5½	17/64	16,264	57/16	15/32	14,625
4½	16.60	IEU 135	NC46	6¼	2¾	22,436 P	525/32	23/64	21,230	521/32	21/64	18,083
	16.60	EU 135	NC50	6%	3½	22,336 P	61/16	31/64	21,018	531/32	9/32	18,368
4½	20.00	IEU 75	4½ FH	6	3	17,390 P	515/32	¼	14,231	5%	13/64	12,125
	20.00	IEU 75	NC46	6¼	3	19,829 P	5½	¼	14,288	513/32	13/64	12,085
	20.00	EU 75	NC50	6%	3%	20,617 P	513/16	13/64	14,082	5¾	11/64	12,415
	20.00	IEU 75	4½ H-90	6	3	22,616 P	513/32	7/32	13,815	511/32	3/16	12,215
4½	20.00	IEU 95	4½ FH	6	2½	22,133 P	5%	21/64	17,861	517/32	9/32	15,665
	20.00	IEU 95	NC46	6¼	2¾	22,436 P	521/32	21/64	18,083	59/16	9/32	15,787
	20.00	EU 95	NC50	6%	3½	22,336 P	515/16	17/64	17,497	5%	15/64	15,776
	20.00	EU 95	4½ H-90	6	3	22,616 P	59/16	19/64	17,929	515/32	¼	15,441
4½	20.00	IEU 105	NC46	6¼	2½	24,815 P	523/32	23/64	19,644	5%	5/16	17,311
	20.00	EU 105	NC50	6%	3½	22,336 P	61/32	5/16	20,127	529/32	¼	16,634
4½	20.00	EU 135	NC50	6%	2¾	30,332 P	67/32	13/32	25,569	63/32	11/32	21,914
5	19.50	IEU 75	NC50	6%	3¾	18,838 P	5%	15/64	15,776	513/16	13/64	14,083
5	19.50	IEU 95	NC50	6%	3½	22,345 P	61/32	5/16	19,919	515/16	17/64	17,497
	19.50	IEU 95	5 H-90	6½	3¼	25,932 P	527/32	19/64	19,862	5¾	¼	17,136
5	19.50	IEU 105	NC50	6½	3¼	25,724 P	63/32	11/32	21,914	6	19/64	19,244
	19.50	IEU 105	5 H-90	6½	3	29,231 P	529/32	21/64	21,727	513/16	9/32	18,961
5	19.50	IEU 135	NC50	6%	2¾	31,703 P	65/16	29/64	28,381	63/16	25/64	24,645
	19.50	IEU 135	5½ FH	7¼	3½	36,241 P	6¾	¾	28,737	6%	5/16	24,413

TABLE 2.12 (continued)
RECOMMENDED MINIMUM OD* AND MAKE-UP TORQUE OF
WELD-ON TYPE TOOL JOINTS BASED ON TORSIONAL STRENGTH
OF BOX AND DRILL PIPE

1	2	3	4	5	6	7	8	9	10	11	12	
DRILL PIPE			NEW TOOL JOINT DATA				PREMIUM CLASS			CLASS 2		
NOM SIZE	NOM WT.	TYPE UPSET AND GRADE	CONN.	NEW OD	NEW ID	MAKE-UP TORQUE	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT	MIN OD TOOL JOINT	MIN BOX SHOULDER WITH ECCEN- TRIC WEAR	MAKE-UP TORQUE FOR MIN OD TOOL JOINT
								in.	in.		ft-lb	in.
5	25.60	IEU 75	NC50	6%	3½	22,337 P	6⅛ ₃₂	5/16	20,127	5⅛ ₁₆	17/64	17,497
	25.60	IEU 75	5½ FH	7	3½	31,452 B	6½	¼	20,205	6⅛ ₃₂	13/64	17,126
5	25.60	IEU 95	NC50	6½	3	28,492 B	67/32	13/32	25,569	63/32	11/32	21,914
	25.60	IEU 95	5½ FH	7	3½	34,947 B	621/32	21/64	25,450	617/32	15/64	21,246
5	25.60	IEU 105	NC50	6%	2¾	31,703 P	69/32	7/16	27,438	65/32	¾	23,729
	25.60	IEU 105	5½ FH	7¼	3½	36,241 P	623/32	23/64	27,644	6%	5/16	24,412
5	25.60	IEU 135	5½ FH	7¼	3½	39,358 B	615/16	15/32	35,446	613/16	13/32	30,943
5½	21.90	IEU 75	5½ FH	7	4	27,967 P	615/32	¼	19,172	613/32	13/32	17,127
5½	21.90	IEU 95	5½ FH	7	3¾	31,452 B	621/32	21/64	25,483	617/32	17/64	21,246
	21.90	IEU 95	5½ H-90	7	3½	29,576 P	67/32	11/32	25,478	63/32	9/32	21,349
5½	21.90	IEU 105	5½ FH	7¼	3½	36,241 P	623/32	23/64	27,645	619/32	19/32	23,350
5½	21.90	IEU 135	5½ FH	7½	3	43,585 P	615/16	15/32	35,446	613/16	13/32	30,943
5½	24.70	IEU 75	5½ FH	7	4	27,967 P	69/16	9/32	22,294	615/32	15/64	19,172
5½	24.70	IEU 95	5½ FH	7¼	3½	31,452 B	623/32	23/64	27,645	619/32	19/64	23,350
5½	24.70	IEU 105	5½ FH	7¼	3½	31,452 B	625/32	25/64	29,836	611/16	11/32	26,560
5½	24.70	IEU 135	5½ FH	7½	3	43,585 P	71/32	33/64	38,901	6¾	7/16	33,180

- ① The use of outside diameters (OD) smaller than those listed in the table may be acceptable on Slim Hole (SH) tool joints due to special service requirements.
- ② Tool joint with dimensions shown has a lower torsional yield ratio than the 0.80 which is generally used.
- ③ Recommended make-up torque is based on 72,000 psi stress.
- ④ 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 I.D. of the counter bore to the outside diameter of the box, disregarding the bevels.
- ⑤ Any tool joint with an outside diameter less than the API bevel diameter should be provided with a minimum 1/32" depth × 45° bevel on the outside and inside diameter of the box shoulder and outside diameter of the pin shoulder.
- ★ Tool joint diameters specified are required to retain torsional strength in the tool joint comparable to the torsional strength of the attached drill pipe. These should be adequate for all service. Tool joints with torsional strengths considerably below that of the drill pipe may be adequate for much drilling service.

TABLE 2.13
BUOYANCY FACTORS

1	2	3
Mud Density lb/gal	Mud Density lb/cu ft	Buoyancy Factor, K _b ,
8.4	62.84	.872
8.6	64.33	.869
8.8	65.83	.866
9.0	67.32	.862
9.2	68.82	.859
9.4	70.32	.856
9.6	71.81	.853
9.8	73.31	.850
10.0	74.80	.847
10.2	76.30	.844
10.4	77.80	.841
10.6	79.29	.838
10.8	80.79	.835
11.0	82.29	.832
11.2	83.78	.829
11.4	85.28	.826
11.6	86.77	.823
11.8	88.27	.820
12.0	89.77	.817
12.2	91.26	.814
12.4	92.76	.811
12.6	94.25	.807
12.8	95.75	.804
13.0	97.25	.801
13.2	98.74	.798
13.4	100.24	.795
13.6	101.74	.792
13.8	103.23	.789
14.0	104.73	.786
14.2	106.22	.783
14.4	107.72	.780
14.6	109.22	.777
14.8	110.71	.774
15.0	112.21	.771
15.2	113.70	.768
15.4	115.20	.765
15.6	116.70	.762
15.8	118.19	.759
16.0	119.69	.756
16.2	121.18	.752
16.4	122.68	.749
16.6	124.18	.746
16.8	125.67	.743
17.0	127.17	.740
17.2	128.66	.737
17.4	130.16	.734
17.6	131.66	.731
17.8	133.15	.728
18.0	134.65	.725
18.5	138.39	.717
19.0	142.13	.710
19.5	145.87	.702
20.0	149.61	.694

2.9 Many sizes and styles of connections are interchangeable with certain other sizes and styles of connections. These conditions differ only in name and in some cases thread form. If the thread forms are interchangeable, the connections are interchangeable.

These interchangeable connections are:

TABLE 2.14
ROTARY SHOULDERED CONNECTION
INTERCHANGE LIST

Common Name	Pin Base Diameter (Tapered)	Threads Per in	Taper in/ft	Thread Form*	Same As or Interchanges With
Style	Size				
Internal Flush (I.F.)	2 3/8"	2.876	4	2	V-0.065 (V-0.038 rad) 2 3/8" Slim Hole N.C. 26**
	2 7/8"	3.391	4	2	V-0.065 (V-0.038 rad) 3 1/2" Slim Hole N.C. 31**
	3 1/2"	4.016	4	2	V-0.065 (V-0.038 rad) 4 1/2" Slim Hole N.C. 38**
	4"	4.834	4	2	V-0.065 (V-0.038 rad) 4 1/2" Extra Hole N.C. 46**
	4 1/2"	5.250	4	2	V-0.065 (V-0.038 rad) 5" Extra Hole N.C. 50** 5 1/2" Double Streamline
Full Hole (F.H.)	4"	4.280	4	2	V-0.065 (V-0.038 rad) 4 1/2" Double Streamline N.C. 40**
Extra Hole (X.H.) (E.H.)	2 3/8"	3.327	4	2	V-0.065 (V-0.038 rad) 3 1/2" Double Streamline
	3 1/2"	3.812	4	2	V-0.065 (V-0.038 rad) 4" Slim Hole 4 1/2" External Flush
	4 1/2"	4.834	4	2	V-0.065 (V-0.038 rad) 4" Internal Flush N.C. 46**
	5"	5.250	4	2	V-0.065 (V-0.038 rad) 4 1/2" Internal Flush N.C. 50** 5 1/2" Double Streamline
Slim Hole (S.H.)	2 3/8"	2.876	4	2	V-0.065 (V-0.038 rad) 2 3/8" Internal Flush N.C. 26**
	3 1/2"	3.391	4	2	V-0.065 (V-0.038 rad) 2 3/8" Internal Flush N.C. 31**
	4"	3.812	4	2	V-0.065 (V-0.038 rad) 3 1/2" Extra Hole 4 1/2" External Flush
	4 1/2"	4.016	4	2	V-0.065 (V-0.038 rad) 3 1/2" Internal Flush N.C. 38**
Double Streamline (DSL)	3 1/2"	3.327	4	2	V-0.065 (V-0.038 rad) 2 3/8" Extra Hole
	4 1/2"	4.280	4	2	V-0.065 (V-0.038 rad) 4" Full Hole N.C. 40**
	5 1/2"	5.250	4	2	V-0.065 (V-0.038 rad) 4 1/2" Internal Flush 5" Extra Hole N.C. 50**
Numbered Conn (N.C.)	26	2.876	4	2	V-0.038 rad 2 3/8" Internal Flush 2 3/8" Slim Hole
	31	3.391	4	2	V-0.038 rad 2 3/8" Internal Flush 3 1/2" Slim Hole
	38	4.016	4	2	V-0.038 rad 3 1/2" Internal Flush 4 1/2" Slim Hole
	40	4.280	4	2	V-0.038 rad 4" Full Hole 4 1/2" Double Streamline
	46	4.834	4	2	V-0.038 rad 4" Internal Flush 4 1/2" Extra Hole
	50	5.250	4	2	V-0.038 rad 4 1/2" Internal Flush 5" Extra Hole 5 1/2" Double Streamline
External Flush (E.F.)	4 1/2"	3.812	4	2	V-0.065 (V-0.038 rad) 4" Slim Hole 3 1/2" Extra Hole

* Connections with two thread forms shown may be machined with either thread form without affecting gaging or interchangeability.

** Numbered connections (N.C.) may be machined only with the V-0.038 radius thread form.

2.10 The curves of Figures 2.1 through 2.25 depict the theoretical torsional yield strength of a number of commonly used tool joint connections over a wide range of inside and outside diameters. The coefficient of friction on mating surfaces, threads and shoulders, is assumed to be 0.08. The make-up torque should be based on a tensile stress level of 50% of the minimum yield for new tool joints and 60% for used tool joints.

2.11 The curves may be used by taking the following steps:

- Select the appropriately titled curve for the size and type tool joint connection being studied.
- Extend a horizontal line from the OD under consideration to the curve and read the torsional strength representing the box.
- 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.

2.12 The recommended make-up torque for a used tool joint is determined by taking the following steps:

- Select the appropriately titled curve for the size and type tool joint connection being studied.
- Extend a horizontal line from the O.D. under consideration to the curve and read the recommended make-up torque representing the box.
- Extend a vertical line from the I.D. 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.

TOOL JOINT TORSIONAL STRENGTH AND RECOMMENDED MAKE-UP TORQUE CURVES
(All curves based on 120,000 psi minimum yield strength and 60% of minimum yield strength for recommended make-up torque)

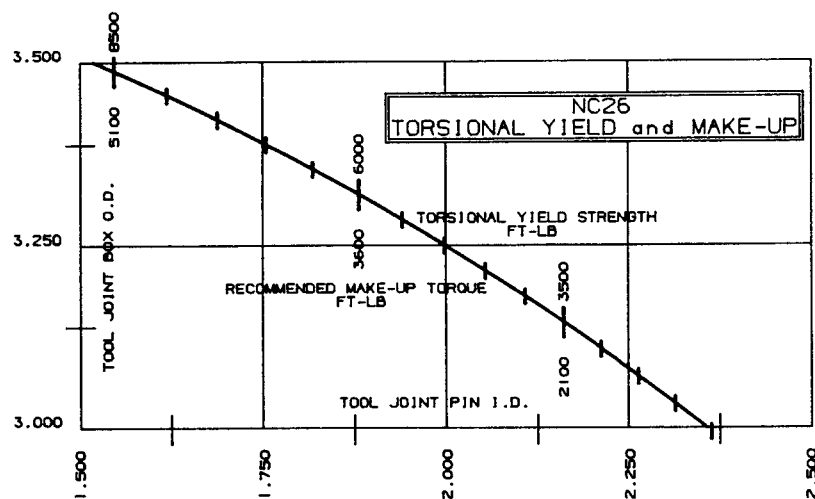


FIG. 2.1

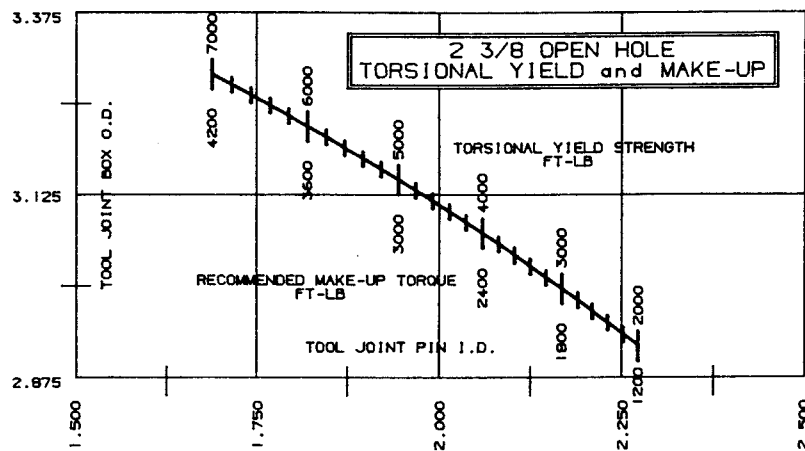


FIG. 2.2

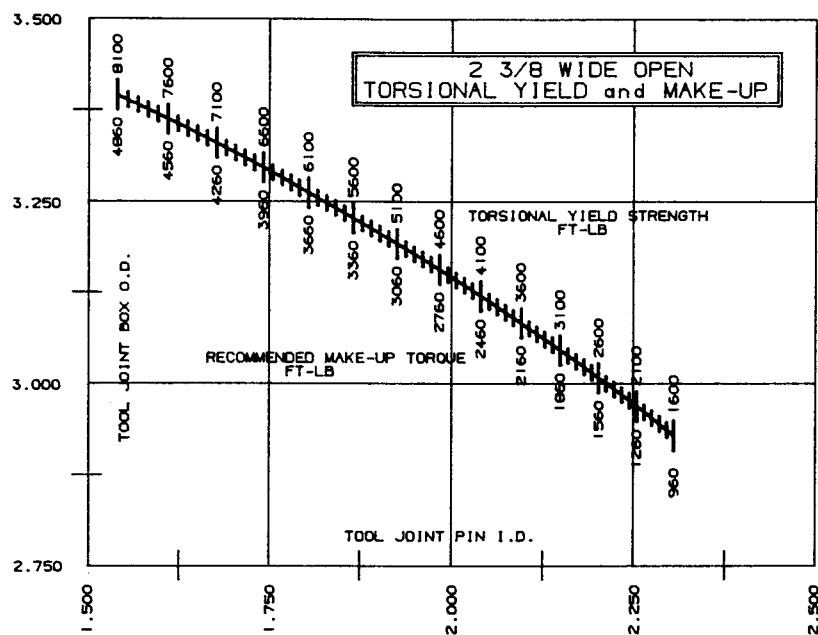


FIG. 2.3

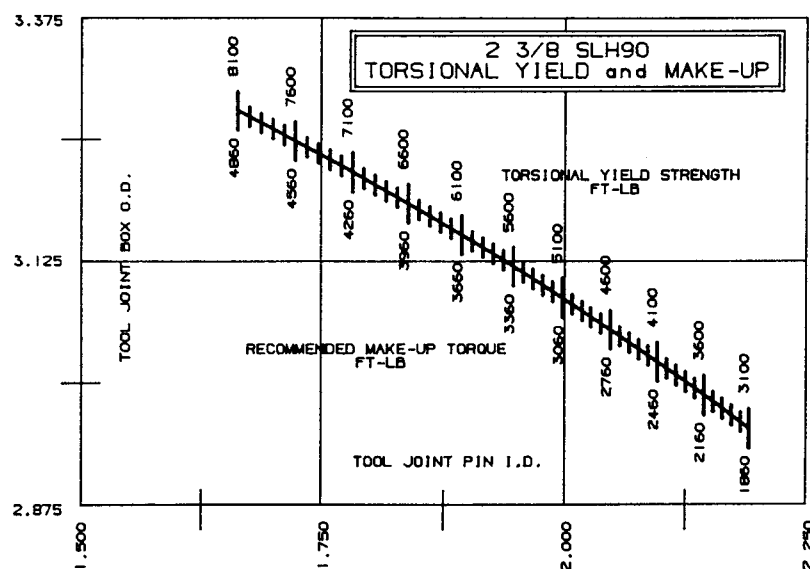


FIG. 2.4