INTERNATIONAL STANDARD

ISO 10407

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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

Reference number
ISO 10407:1993(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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): °C = 5/9 (°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
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Users of this publication should become completely familiar with its scope and content. This publication is intended to supplement rather than replace individual engineering judgment.

OFFICIAL PUBLICATION

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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 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
2⅜	4.85	4.43	.190	1.995	1.3042	1.321
	6.65	6.26	.280	1.815	1.8429	1.733
2⅞	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
6⅝	25.20	22.19	.330	5.965	6.5262	19.572

[1] lb/ft = 3.3996 x A (col. 6)

[2] $A = 0.7854\,(D^2 - d^2)$

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

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* Torsional Yield Strength, ft-lb				Tensile Data Based on Minimum Values** Load at the Minimum Yield Strength, lb;			
		E	95	105	135	E	95	105	135
2⅜	4.85	4763.	6033.	6668.	8574.	97817.	123902.	136944.	176071.
	6.65	6250.	7917.	8751.	11251.	138214.	175072.	193500.	248786.
2⅞	6.85	8083.	10238.	11316.	14549.	135902.	172143.	190263.	244624.
	10.40	11554.	14635.	16176.	20798.	214344.	271503.	300082.	385820.
3½	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.
4½	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.
5½	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.
6⅝	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.