BRITISH STANDARD

BS EN ISO 10405:2006

Petroleum and natural gas industries— Care and use of casing and tubing

ICS 23.040.01;75.180.10

British Standards

National foreword

This British Standard is the UK implementation of EN ISO 10405:2006. It is identical with ISO 10405:2000. BS EN ISO 10405:2006 supersedes BS ISO 10405:2000.

The UK participation in its preparation was entrusted to Technical Committee PSE/17, Petroleum and natural gas industries.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 May 2001

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EUROPEAN STANDARD

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EN ISO 10405

November 2006

ICS 75.180.10

English Version

Petroleum and natural gas industries - Care and use of casing and tubing (ISO 10405:2000)

Industries du pétrole et du gaz naturel - Entretien et utilisation des tubes de cuvelage et de production (ISO 10405:2000)

Erdöl- und Erdgasindustrie - Pflege und Gebrauch von Futterrohren und Steigrohren (ISO 10405:2000)

This European Standard was approved by CEN on 9 November 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Foreword

The text of ISO 10405:2000 has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 10405:2006 by Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2007, and conflicting national standards shall be withdrawn at the latest by May 2007.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 10405:2000 has been approved by CEN as EN ISO 10405:2006 without any modifications.

INTERNATIONAL STANDARD

ISO 10405

Second edition
2000-03-01

Petroleum and natural gas industries — Care and use of casing and tubing

Industries du pétrole et du gaz naturel — Entretien et utilisation des tubes de cuvelage et de production

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10405 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 5, *Casing, tubing and drill pipe*.

This second edition cancels and replaces the first edition (ISO 10405:1993), which has been technically revised.

Annex A of this International Standard is for information only.

Petroleum and natural gas industries — Care and use of casing and tubing

1 Scope

This International Standard establishes practices for care and use of casing and tubing. It specifies practices for running and pulling casing and tubing, including drifting, stabbing, making up and lowering, field makeup, drifting and landing procedures. Also included are causes of trouble, as well as transportation, handling and storage, inspection and field welding of attachments.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 10400:1993, *Petroleum and natural gas industries — Formulae and calculation for casing, tubing, drill pipe and line pipe properties* [API Bul 5C3, *Bulletin on Formulas and Calculations for Casing, Tubing, Drill Pipe, and Line Pipe Properties*].

ISO 10422:1993, *Petroleum and natural gas industries — Threading, gauging, and thread inspection of casing, tubing and line pipe threads — Specification* [API Spec 5B, *Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*].

ISO 11960:—[1)], *Petroleum and natural gas industries — Steel pipes for use as casing or tubing for wells* [API Spec 5CT, *Specification for Casing and Tubing*].

API[2)] Bul 5A3, *Bulletin on Thread Compounds for Casing, Tubing, and Line Pipe*.

API Bul 5C2, *Bulletin on Performance Properties of Casing, Tubing, and Drill Pipe*.

AWS[3)] Spec A5.1, *Covered Carbon Steel Arc Welding Electrodes*.

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1) To be published. (Revision of ISO 11960:1996)

2) American Petroleum Institute, 1220 L Street NW, Washington DC, USA.

3) American Welding Society, 550 N.W. LeJeune Rd, PO Box 351040, Miami, FL 33135, USA.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply:

3.1
shall
is used to indicate that a provision is mandatory

3.2
should
is used to indicate that a provision is not mandatory, but recommended as good practice

3.3
may
is used to indicate that a provision is optional

4 Running and pulling casing

4.1 Preparation and inspection before running

4.1.1 New casing is delivered free of injurious defects as defined in ISO 11960 or API Specification 5CT and within the practical limits of the inspection procedures prescribed therein. Some users have found that, for a limited number of critical well applications, these procedures do not result in casing sufficiently free of defects to meet their needs for such critical applications. Various nondestructive inspection services have been employed by users to ensure that the desired quality of casing is being run. In view of this practice, it is suggested that the individual user:

a) Familiarize himself with inspection practices specified in the standards and employed by the respective mills, and with the definition of “injurious defect” contained in the standards.

b) Thoroughly evaluate any nondestructive inspection to be used by him on tubular goods to assure himself that the inspection does in fact correctly locate and differentiate injurious defects from other variables that can be and frequently are sources of misleading “defect” signals with such inspection methods.

4.1.2 All casing, whether new, used or reconditioned, should always be handled with thread protectors in place. Casing should be handled at all times on racks or on wooden or metal surfaces free of rocks, sand or dirt other than normal drilling mud. When lengths of casing are inadvertently dragged in the dirt, the threads should be recleaned and serviced again as outlined in 4.1.7.

4.1.3 Slip elevators are recommended for long strings. Both spider and elevator slips should be clean and sharp and should fit properly. Slips should be extra long for heavy casing strings. The spider shall be level.

NOTE Slip and tong marks are injurious. Every possible effort should be made to keep such damage at a minimum by using proper up-to-date equipment.

4.1.4 If collar-pull elevators are used, the bearing surface should be carefully inspected for (a) uneven wear that may produce a side lift on the coupling with danger of it jumping off, and (b) uniform distribution of the load when applied over the bearing face of the coupling.

4.1.5 Spider and elevator slips should be examined and watched to see that all lower together. If they lower unevenly, there is danger of denting the pipe or badly slip-cutting it.

4.1.6 Care shall be exercised, particularly when running long casing strings, to ensure that the slip bushing or bowl is in good condition. Tongs may be sized to produce 1,5 % of the calculated pullout strength (see ISO 10400 or API Bulletin 5C3, with the units changed to N·m if necessary) (150 % of the guideline torque given in Table 1). Tongs should be examined for wear on hinge pins and hinge surfaces. The backup line attachment to the backup post should be corrected, if necessary, to be level with the tong in the backup position so as to avoid uneven load distribution on the gripping surfaces of the casing. The length of the backup line should be such as to cause minimum bending stresses on the casing and to allow full stroke movement of the makeup tong.

4.1.7 The following precautions should be taken in the preparation of casing threads for makeup in the casing strings:

a) Immediately before running, remove thread protectors from both field and coupling ends and clean the threads thoroughly, repeating as additional rows become uncovered.

b) Carefully inspect the threads. Those found damaged, even slightly, should be laid aside unless satisfactory means are available for correcting thread damage.

c) The length of each piece of casing shall be measured prior to running. A steel tape calibrated in millimetres (feet) to the nearest 3,0 mm (0,01 ft) should be used. The measurement should be made from the outermost face of the coupling or box to the position on the externally threaded end where the coupling or the box stops when the joint is made up power-tight. On round-thread joints, this position is to the plane of the vanish point on the pipe; on buttress-thread casing, this position is to the base of the triangle stamp on the pipe; and on extreme-line casing, this position is to the shoulder on the externally threaded end. The total of the individual lengths so measured will represent the unloaded length of the casing string. The actual length under tension in the hole can be obtained by consulting graphs that are prepared for this purpose and are available in most pipe handbooks.

d) Check each coupling for makeup. If the standoff is abnormally great, check the coupling for tightness. Tighten any loose couplings after thoroughly cleaning the threads and applying fresh compound over entire thread surfaces, and before pulling the pipe into the derrick.

e) Before stabbing, liberally apply thread compound to the entire internally and externally threaded areas. It is recommended that a thread compound that meets the performance objectives of API Bulletin 5A3 be used; however, in special cases where severe conditions are encountered, it is recommended that high-pressure silicone thread compounds as specified in API Bulletin 5A3 be used.

f) Place a clean thread protector on the field end of the pipe so that the thread will not be damaged while rolling pipe on the rack and pulling into the derrick. Several thread protectors may be cleaned and used repeatedly for this operation.

g) If a mixed string is to be run, check to determine that appropriate casing will be accessible on the pipe rack when required according to the programme.

h) Connectors used as tensile and lifting members should have their thread capacity carefully checked to ensure that the connector can safely support the load.

i) Care should be taken when making up pup joints and connectors to ensure that the mating threads are of the same size and type.

4.2 Drifting of casing

4.2.1 It is recommended that each length of casing be drifted for its entire length just before running, with mandrels conforming to ISO 11960 or API Specification 5CT. Casing that will not pass the drift test should be laid aside.

4.2.2 Lower or roll each piece of casing carefully to the walk without dropping. Use rope snubber if necessary. Avoid hitting casing against any part of derrick or other equipment. Provide a hold-back rope at the window. For mixed or unmarked strings, a drift or “jack” rabbit should be run through each length of casing when it is picked up from the catwalk and pulled onto the derrick floor to avoid running a heavier length or one with a lesser inside diameter than called for in the casing string.

4.3 Stabbing, making up and lowering

4.3.1 Do not remove thread protector from field end of casing until ready to stab.

4.3.2 If necessary, apply thread compound over the entire surface of threads just before stabbing. The brush or utensil used in applying thread compound should be kept free of foreign matter, and the compound should never be thinned.

4.3.3 In stabbing, lower casing carefully to avoid injuring threads. Stab vertically, preferably with the assistance of a man on the stabbing board. If the casing stand tilts to one side after stabbing, lift up, clean and correct any damaged thread with a three-cornered file, then carefully remove any filings and reapply compound over the thread surface. After stabbing, the casing should be rotated very slowly at first to ensure that threads are engaging properly and not cross-threading. If spinning line is used, it should pull close to the coupling.

NOTE Recommendations in 4.3.4 and 4.4.1 for casing makeup apply to the use of power tongs. For recommendations on makeup of casing with spinning lines and conventional tongs, see 4.4.2.

4.3.4 The use of power tongs for making up casing made desirable the establishment of recommended torque values for each size, mass and grade of casing. Early studies and tests indicated that torque values are affected by a large number of variables, such as variations in taper, lead, thread height and thread form, surface finish, type of thread compound, length of thread, mass and grade of pipe, etc. In view of the number of variables and the extent that these variables, alone or in combination, could affect the relationship of torque values versus made-up position, it was evident that both applied torque and made-up position have to be considered. Since the joint pullout strength formula in API Bulletin 5C2 contains several of the variables believed to affect torque, using a modified formula to establish torque values was investigated. Torque values obtained by taking 1 % of the calculated pullout value were found to be generally comparable to values obtained by field makeup tests using API modified thread compound in accordance with API Bulletin 5A3. Compounds other than API modified thread compound may have other torque values. This procedure was therefore used to establish the makeup torque values listed in Table 1. All values are rounded to the nearest 10 N·m (10 ft·lbf). These values shall be considered as a guide only, due to the very wide variations in torque requirements that can exist for a specific connection. Because of this, it is essential that torque be related to made-up position as outlined in 4.4.1. The torque values listed in Table 1 apply to casing with zinc-plated or phosphate-coated couplings. When making up connections with tin-plated couplings, 80 % of the listed value can be used as a guide. The listed torque values are not applicable for making up couplings with PTFE (polytetrafluoroethylene) rings. When making up round thread connections with PTFE rings, 70 % of the listed values are recommended. Buttress connections with PTFE seal rings may make up at torque values different from those normally observed on standard buttress threads.

NOTE Thread galling of gall-prone materials (martensitic chromium steels, 9 Cr and 13 Cr, duplex stainless steels and Ni base alloys) occurs during movement — stabbing or pulling and makeup or breakout. Galling resistance of threads is primarily controlled in two areas — in surface preparation and finishing during manufacture and in careful handling practices during running and pulling.

Threads and lubricant shall be clean. Assembly in the horizontal position should be avoided. Connections should be turned by hand to the hand-tight position before slowly power-tightening. The procedure should be reversed for disassembly.

4.4 Field makeup

4.4.1 The following practice is recommended for field makeup of casing:

a) For round thread, 114,3 mm (4 1/2-in) to 339,7 mm (13 3/8-in) outside diameter (OD):

1) It is advisable when starting to run casing from each particular mill shipment to make up sufficient joints to determine the torque necessary to provide proper makeup. See 4.4.2 for the proper number of turns beyond hand-tight position. These values may indicate that a departure from the values listed in Table 1 is advisable. If other values are chosen, the minimum torque should be not less than 75 % of the value selected. The maximum torque should be not more than 125 % of the selected torque.

2) The power tong should be provided with a reliable torque gauge of known accuracy. In the initial stages of makeup, any irregularities of makeup or in speed of makeup should be observed, since these may be indicative of crossed threads, dirty or damaged threads, or other unfavourable conditions. To prevent galling when making up connections in the field, the connections should be made up at a speed not to exceed 25 r/min.

3) Continue the makeup, observing both the torque gauge and the approximately position of the coupling face with respect to the thread vanish point position.

4) The torque values shown in Tables 1 and 2 have been selected to give recommended makeup under normal conditions and should be considered as satisfactory providing the face of the coupling is flush with the thread vanish point or within two thread turns, plus or minus, of the thread vanish point.

5) If the makeup is such that the thread vanish point is buried two thread turns and 75 % of the torque shown in Table 1 is not reached, the joint should be treated as a questionable joint as provided in 4.4.3.

6) If several threads remain exposed when the listed torque is reached, apply additional torque up to 125 % of the value shown in Table 1. If the standoff (distance from the face of the coupling to the thread vanish point) is greater than three thread turns when this additional torque is reached, the joint should be treated as a questionable joint as provided in 4.4.3.

b) For buttress thread casing connections in sizes 114,3 mm (4 1/2-in) to 508,0 mm (20-in) OD, makeup torque values should be determined by carefully noting the torque required to make up each of several connections to the base of the triangle. Then using the torque value thus established, make up the balance of the pipe of that particular weight and grade in the string.

c) For round thread, 406,4 mm (16-in), 473 mm (18 5/8-in) and 508 mm (20-in) OD:

1) Makeup of 406,4 mm (16-in), 473 mm (18 5/8-in) and 508 mm (20-in) OD shall be to a position on each connection represented by the thread vanish point or the base of the triangle using the minimum torque shown in Table 1 as a guide.

On 8-round-thread casing, a 9,5 mm (3/8-in) equilateral triangle is die-stamped at a distance of L_4 + 1,6 mm (1/16 in) from each end (for L_4, see Figure 2.1 in ISO 10422:1993 or API Spec 5B). The base of the triangle will aid in locating the thread vanish point for basic power-tight makeup; however, the position of the coupling with respect to the base of the triangle shall not be a basis for acceptance or rejection of the product. Care shall be taken to avoid cross-threading in starting these larger connections. The tongs selected should be capable of attaining high torques [67 800 N·m (50 000 ft·lbf)] for the entire run. Anticipate that maximum torque values could be five times the minimum experienced in makeup to the recommended position.

2) Joints that are questionable as to their proper makeup in item a) 5) or a) 6) should be unscrewed and laid down to determine the cause of improper makeup. Both the pipe thread and mating coupling thread should be inspected. Damaged threads or threads that do not comply with the specification should be repaired. If damaged or out-of-tolerance threads are not found to be the cause of improper makeup, then the makeup torque should be adjusted to obtain proper makeup [see item a) 1)]. It should be noted that a thread compound with a coefficient of friction substantially different from common values may be the cause of improper makeup.

4.4.2 When conventional tongs are used for casing makeup, tighten with the tongs to the proper degree of tightness. The joint should be made up beyond the hand-tight position at least three turns for sizes 114,3 mm (4 1/2 in) to 117,8 mm (7 in), and at least three-and-one-half turns for sizes 193,7 mm (7 5/8 in) and larger, except 244,5 mm (9 5/8 in) and 273,1 mm (10 3/4-in) grade P-110, and 508 mm (20-in) grade J-55 and K-55, which should be made up four turns beyond the hand-tight position. When using a spinning line, it is necessary to compare hand tightness with spin-up tightness. In order to do this, make up the first few joints to the hand-tight position, then back off and spin up joints to the spin-up tight position. Compare the relative positions of these two makeups and use this information to determine when the joint is made up the recommended number of turns beyond hand tight.

4.4.3 Joints that are questionable as to their proper tightness should be unscrewed and the casing laid down for inspection and repair. When this is done, the mating coupling should be carefully inspected for damaged threads. Parted joints should never be re-used without shopping or regauging, even though the joints may have little appearance of damage.

4.4.4 If casing has a tendency to wobble unduly at its upper end when making up, indicating that the thread may not be in line with the axis of the casing, the speed of rotation should be decreased to prevent galling of threads. If wobbling persists despite the reduced rotational speed, the casing should be laid down for inspection. Serious consideration should be given before using such casing in a position in the string where a heavy tensile load is imposed.

4.4.5 In making up the field joint, it is possible for the coupling to make up slightly on the mill end. This does not indicate that the coupling on the mill end is too loose but simply that the field end has reached the tightness with which the coupling was screwed on at the manufacturer's facility.

4.4.6 Casing strings should be picked up and lowered carefully and care exercised in setting slips to avoid shock loads. Dropping a string even a short distance may loosen couplings at the bottom of the string. Care should be exercised to avoid setting casing down on its bottom end or otherwise placing it in compression because of the danger of buckling, particularly in that part of the well where hole enlargement has occurred.

4.4.7 Definite instructions should be available as to the design of the casing string, including the proper location of the various grades of steel, weights of casing and types of joint. Care should be exercised to run the string in exactly the order in which it was designed. If any length cannot be clearly identified, it should be laid aside until its grade, its weight or the type of joint can be positively established.

4.4.8 To facilitate running and to ensure adequate hydrostatic head to contain reservoir pressures, the casing should be periodically filled with mud while being run. A number of things govern the frequency with which filling should be accomplished: weight of pipe in the hole, mud weight, reservoir pressure, etc. In most cases, filling every six to ten lengths should suffice. The hydrostatic balance of reservoir pressure should not be jeopardized by too infrequent filling. Filling should be done with mud of the proper weight, using a conveniently located hose of adequate size to expedite the filling operation. A quick-opening/quick-closing plug valve on the mud hose will facilitate the operation and prevent overflow. If rubber hose is used, it is recommended that the quick-closing valve be mounted where the hose is connected to the mud line, rather than at the outlet end of the hose. It is also recommended that at least one other discharge connection be left open on the mud system to prevent buildup of excessive pressure when the quick-closing valve is closed while the pump is still running. A copper nipple at the end of the mud hose may be used to prevent damaging the coupling threads during the filling operation.

NOTE The foregoing mud fill-up practice will be unnecessary if automatic fill-up casing shoes and collars are used.

4.5 Casing landing procedure

Definite instructions should be provided for the proper string tension, also on the proper landing procedure after the cement has set. The purpose is to avoid critical stresses or excessive and unsafe tensile stresses at any time during the life of the well. In arriving at the proper tension and landing procedure, consideration should be given to all factors, such as the well temperature and pressure, the temperature developed due to cement hydration, the mud temperature and changes of temperature during producing operations. The adequacy of the original tension safety factor of the string as designed will influence the landing procedure and should be considered. If, however, after due consideration it is not considered necessary to develop special landing procedure instructions (and this probably applies to a very large majority of the wells drilled), then the procedure should be followed of landing the casing in the casing head at exactly the position in which it was hanging when the cement plug reached its lowest point or "as cemented."

4.6 Care of casing in hole

Drill pipe run inside casing should be equipped with suitable drill-pipe protectors.

4.7 Recovery of casing

4.7.1 Breakout tongs should be positioned close to the coupling but not too close since a slight squashing effect where the tong dies contact the pipe surface cannot be avoided, especially if the joint is tight and/or the casing is light. Keeping a space of one-third to one-quarter of the diameter of the pipe between the tongs and the coupling should normally prevent unnecessary friction in the threads. Hammering the coupling to break the joint is an injurious practice. If tapping is required, use the flat face, never the peen face of the hammer, and under no circumstances should a sledge-hammer be used. Tap lightly near the middle and completely around the coupling, never near the end or on opposite sides only.

4.7.2 Great care should be exercised to disengage all of the thread before lifting the casing out of the coupling. Do not jump casing out of the coupling.

4.7.3 All threads should be cleaned and lubricated or should be coated with a material that will minimize corrosion. Clean protectors should be placed on the casing before it is laid down.

4.7.4 Before casing is stored or reused, pipe and thread should be inspected and defective joints marked for shopping and regauging.

4.7.5 When casing is being retrieved because of a casing failure, it is imperative to future prevention of such failures that a thorough metallurgical study be made. Every attempt should be made to retrieve the failed portion in the “as-failed” condition. When thorough metallurgical analysis reveals some facet of pipe quality to be involved in the failure, the results of the study should be reported.

4.7.6 Casing stacked in the derrick should be set on a firm wooden platform and without the bottom thread protector since the design of most protectors is not such as to support the joint or stand without damage to the field thread.

4.8 Causes of casing trouble

4.8.1 The more common causes of casing trouble are listed in 4.8.2 to 4.8.17.

4.8.2 Improper selection for the depth and pressures encountered.

4.8.3 Insufficient inspection of each length of casing or of field-shop threads.

4.8.4 Abuse in mill, transportation and field handling.

4.8.5 Nonobservance of good rules in running and pulling casing.

4.8.6 Improper cutting of field-shop threads.

4.8.7 The use of poorly manufactured couplings for replacements and additions.

4.8.8 Improper care in storage.

4.8.9 Excessive torquing of casing to force it through tight places in the hole.

4.8.10 Pulling too hard on a string (to free it). This may loosen the couplings at the top of the string. They should be retightened with tongs before finally setting the string.

4.8.11 Rotary drilling inside casing. Setting the casing with improper tension after cementing is one of the greatest contributing causes of such failures.

4.8.12 Drill-pipe wear while drilling inside casing is particularly significant in drifted holes. Excess doglegs in deviated holes, or occasionally in straight holes where corrective measures are taken, result in concentrated bending of the casing that in turn results in excess internal wear, particularly when the doglegs are high in the hole.

4.8.13 Wire-line cutting, by swabbing or cable-tool drilling.

4.8.14 Buckling of casing in an enlarged, washed-out uncemented cavity if too much tension is released in landing.

4.8.15 Dropping a string, even a very short distance.

4.8.16 Leaky joints, under external or internal pressure, are a common cause of trouble, and may be due to the following:

a) improper thread compound;

b) undertonging;

c) dirty threads;

d) galled threads due to dirt, careless stabbing, damaged threads, too rapid spinning, overtonging or wobbling during spinning or tonging operations;

e) improper cutting of field-shop threads;

f) pulling too hard on the string;

g) dropping the string;

h) excessive making and breaking;

i) tonging too high on casing, especially on breaking out (this gives a bending effect that tends to gall the threads);

j) improper joint makeup at the mill;

k) casing ovality or out-of-roundness;

l) improper landing practice, which produces stresses in the threaded joint in excess of the yield point.

4.8.17 Corrosion, which can damage both the inside and outside of casing, can be recognized by the presence of pits or holes in the pipe. Corrosion on the outside of casing can be caused by corrosive fluids or formations in contact with the casing or by stray electric currents flowing out the casing into the surrounding fluids or formations. Severe corrosion may also be caused by sulfate-reducing bacteria. Corrosion damage on the inside is usually caused by corrosive fluids produced from the well, but the damage can be increased by the abrasive effects of casing and tubing pumping equipment and by high fluid velocities such as those encountered in some gas-lifted wells. Internal corrosion might also be due to stray electric currents (electrolysis) or to dissimilar metals in close contact (bimetallic galvanic corrosion).

Because corrosion may result from so many different conditions, no simple or universal remedy can be given for its control. Each corrosion problem shall be treated as an individual case and a solution attempted in the light of the known corrosion factors and operating conditions. The condition of the casing can be determined by visual or optical-instrument inspections. Where these are not practical, a casing-caliper survey can be made to determine the condition of the inside surfaces. No tools have yet been designed for determining the condition of the outside of casing in a well. Internal casing-caliper surveys indicate the extent, location and severity of corrosion. On the basis of the industry's experience to date, the following practices and measures can be used to control corrosion of casing:

a) Where external casing corrosion is known to occur or stray electric current surveys indicate that relatively high currents are entering the well, the following practices can be employed:

   1) good cementing practices, including the use of centralizers, scratchers and adequate amounts of cement to keep corrosive fluids from coming into contact with the outside of the casing;

   2) electrical insulation of flow lines from wells by the use of nonconducting flange assemblies to reduce or prevent electric currents from entering the well;

   3) the use of highly alkaline mud or mud treated with a bactericide as a completion fluid to help alleviate corrosion caused by sulfate-reducing bacteria;

   4) a properly designed cathodic protection system similar to that used for line pipe, to alleviate external casing corrosion. Protection criteria for casing differ somewhat from the criteria used for line pipe. Literature on external casing corrosion or persons competent in this field should be consulted for proper protection criteria.

b) Where internal corrosion is known to exist, the following practices can be employed.

 1) In flowing wells, packing the annulus with fresh water or low-salinity alkaline muds. (It may be preferable in some flowing wells to depend upon inhibitors to protect the inside of the casing and the tubing.)

 2) In pumping wells, avoiding the use of casing pumps. Ordinarily, pumping wells should be tubed as close to bottom as practical, regardless of the position of the pump, to minimize the damage to the casing from corrosive fluids.

 3) Using inhibitors to protect the inside of the casing against corrosion.

c) To determine the value and effectiveness of the above practices and measures, cost and equipment-failure records can be compared before and after application of control measures. Inhibitor effectiveness may also be checked by means of caliper surveys, visual examinations of readily accessible pieces of equipment, and water analyses for iron content. Coupons may also be helpful in determining whether sufficient inhibitor is being used. When lacking previous experience with any of the above measures, they should be used cautiously and on a limited scale until appraised for the particular operating conditions.

d) In general, all new areas should be considered as being potentially corrosive and investigations should be initiated early in the life of a field, and repeated periodically, to detect and localize corrosion before it has caused any destructive damage. These investigations should cover:

 1) a complete chemical analysis of the effluent water, including pH, iron, hydrogen sulfide, organic acids and any other substances that influence or indicate the degree of corrosion. An analysis for carbon dioxide and hydrogen sulfide of the gas produced is also desirable;

 2) corrosion rate tests by using coupons of the same materials as in the well;

 3) the use of caliper or optical-instrument inspections.

 Where conditions favourable to corrosion exist, a qualified corrosion engineer should be consulted. Particular attention should be given to mitigation of corrosion where the probable life of subsurface equipment is less than the time expected to deplete a well.

e) When H_2S is present in the well fluids, casing of high yield strength may be subject to sulfide-corrosion cracking. The concentration of H_2S necessary to cause cracking in materials of different strengths is not yet well defined. Literature on sulfide corrosion or persons competent in this field should be consulted.

5 Running and pulling tubing

5.1 Preparation and inspection before running

5.1.1 New tubing is delivered free of injurious defects as defined in ISO 11960 or API Specification 5CT and within the practical limits of the inspection procedures prescribed therein. Some users have found that, for a limited number of critical well applications, these procedures do not result in tubing sufficiently free of defects to meet their needs for such critical applications. Various nondestructive inspection services have been employed by users to ensure that the desired quality of tubing is being run. In view of this practice, it is suggested that the individual user:

a) familiarize himself with inspection practices specified in the standards and employed by the respective manufacturers, and with the definition of “injurious defect” contained in the standards;

b) thoroughly evaluate any nondestructive inspection to be used by him on tubular goods to assure himself that the inspection does in fact correctly locate and differentiate injurious defects from other variables that can be and frequently are sources of misleading “defect” signals with such inspection methods.

CAUTION — Due to the permissible tolerance on the outside diameter immediately behind the tubing upset, the user is cautioned that difficulties may occur when wrap-around seal-type hangers are installed on tubing manufactured on the high side of the tolerance; therefore, it is recommended that, when selecting the joint of tubing to be installed at the top of the string, the user confirm that the outside diameter is suitable for the intended application.

5.1.2 All tubing, whether new, used, or reconditioned, should always be handled with thread protectors in place. Tubing should be handled at all times on racks or on wooden or metal surfaces free of rocks, sand or dirt other than normal drilling mud. When lengths of tubing are inadvertently dragged in the dirt, the threads should be recleaned and serviced again as outlined in 5.1.9.

5.1.3 Before running in the hole for the first time, tubing should be drifted with a drift mandrel to ensure passage of pumps, swabs and packers.

5.1.4 Elevators should be in good repair and should have links of equal length.

5.1.5 Slip-type elevators are recommended when running special clearance couplings, especially those bevelled on the lower end.

5.1.6 Elevators should be examined to note if latch fitting is complete.

5.1.7 Spider slips that will not crush the tubing should be used. Slips should be examined before use to see that they are working together.

NOTE Slip and tong marks are injurious. Every possible effort should be made to keep such damage at a minimum by using proper up-to-date equipment.

5.1.8 Tubing tongs that will not crush the tubing should be used on the body of the tubing, and they should fit properly to avoid unnecessary cutting of the pipe wall. Tong dies should fit properly and conform to the curvature of the tubing. The use of pipe wrenches is not recommended.

5.1.9 The following precautions should be taken in the preparation of tubing threads.

a) Immediately before running, remove protectors from both field end and coupling end and clean threads thoroughly, repeating as additional rows become uncovered.

b) Carefully inspect the threads. Those found damaged, even slightly, should be laid aside unless satisfactory means are available for correcting thread damage.

c) The length of each piece of tubing shall be measured prior to running. A steel tape calibrated in millimetres (feet) to the nearest 3,0 mm (0,01 ft) should be used. The measurement should be made from the outermost face of the coupling or box to the position on the externally threaded end where the coupling or the box stops when the joint is made up power-tight. The total of the individual lengths so measured will represent the unloaded length of the tubing string. The actual length under tension in the hole can be obtained by consulting graphs that are prepared for this purpose and are available in most pipe handbooks.

d) Place clean protectors on the field end of the pipe so that thread will not be damaged while rolling pipe onto the rack and pulling into the derrick. Several thread protectors may be cleaned and used repeatedly for this operation.

e) Check each coupling for makeup. If the stand-off is abnormally great, check the coupling for tightness. Loose couplings should be removed, the thread thoroughly cleaned, fresh compound applied over the entire thread surfaces, then the coupling replaced and tightened before pulling the tubing into the derrick.

f) Before stabbing, liberally apply thread compound to the entire internally and externally threaded areas. It is recommended that high-pressure modified thread compound as specified in the latest edition of API Bulletin 5A3 be used, except in special cases where severe conditions are encountered, when it is recommended that high-pressure silicone thread compound as specified in API Bulletin 5A3 be used.

g) Connectors used as tensile and lifting members should have their thread capacity carefully checked to ensure that the connector can safely support the load.

h) Care should be taken when making up pup joints and connectors to ensure that the mating threads are of the same size and type.

5.1.10 For high-pressure or condensate wells, additional precautions should be taken to ensure tight joints as follows.

a) Couplings should be removed, and both the mill-end pipe thread and coupling thread thoroughly cleaned and inspected. To facilitate this operation, tubing may be ordered with couplings handling-tight, which is approximately one turn beyond hand-tight, or it may be ordered with the couplings shipped separately.

b) Thread compound should be applied to both the external and internal threads, and the coupling should be reapplied handling-tight. Field-end threads and the mating coupling threads should have thread compound applied just before stabbing.

5.1.11 When tubing is pulled into the derrick, care should be taken that the tubing is not bent or couplings or protectors bumped.

5.2 Stabbing, making up and lowering

5.2.1 Do not remove the thread protector from the field end of tubing until ready to stab.

5.2.2 If necessary, apply thread compound over the entire surface of threads just before stabbing. The brush or utensil used in applying thread compound should be kept free of foreign matter, and the compound should never be thinned.

5.2.3 In stabbing, lower tubing carefully to avoid injuring the threads. Stab vertically, preferably with the assistance of a man on the stabbing board. If the tubing tilts to one side after stabbing, lift up, clean and correct any damaged thread with a three-cornered file, then carefully remove any filings and reapply compound over the thread surface. Care should be exercised, especially when running doubles or triples, to prevent bowing and resulting errors in alignment when the tubing is allowed to rest too heavily on the coupling threads. Intermediate supports may be placed in the derrick to limit bowing of the tubing.

5.2.4 After stabbing, start screwing by hand or apply regular or power tubing tongs slowly. To prevent galling when making connections in the field, the connections should be made up at a speed not exceeding 25 r/min. Power tubing tongs are recommended for high-pressure or condensate wells to ensure uniform makeup and tight joints. Joints should be made up tight, approximately two turns beyond the hand-tight position, with care being taken not to gall the threads. When the additional preparation and inspection precautions for high-pressure or condensate wells are taken, the coupling will “float” or make up simultaneously at both ends until the proper number of turns beyond the hand-tight position have been obtained. The hand-tight position may be determined by checking several joints on the rack and noting the number of threads exposed when a coupling is made up with a torque of 68 N·m (50 ft·lbf).

5.3 Field makeup

5.3.1 Joint life of tubing under repeated field makeup is inversely proportional to the field makeup torque applied. Therefore, in wells where leak resistance is not a great factor, minimum field makeup torque values should be used to prolong joint life. The use of power tongs for making up tubing made desirable the establishment of recommended torque values for each size, mass and grade of tubing. Table 3 contains makeup torque guidelines for nonupset, external-upset, and integral-joint tubing, based on 1 % of the calculated joint pullout strength determined from the joint pullout strength formula for 8-round-thread casing in ISO 10400 or API Bulletin 5C3. All values are rounded to the nearest 10 N·m (10 ft·lbf). The torque values listed in Table 3 apply to tubing with zinc-plated or phosphate-coated couplings. When making up connections with tin-plated couplings, 80 % of the listed value can be used as a guide.

5.3.2 When making up round-thread connections with PTFE (polytetrafluoroethylene) rings, 70 % of the listed values are recommended. As with standard couplings, makeup positions shall govern. Buttress connections with PTFE seal rings may make up at torque values different from those normally observed on standard buttress threads.

NOTE Thread galling of gall-prone materials (martensitic chromium steels, 9 Cr and 19 Cr, duplex stainless steels and Ni base alloys) occurs during movement — stabbing or pulling and makeup or breakout. Galling resistance of threads is primarily controlled in two areas — surface preparation and finishing during manufacture and careful handling practices during running and pulling. Threads and lubricant shall be clean. Assembly in the horizontal position should be avoided. Connections should be turned by hand to the hand-tight position before slowly power-tightening. The procedure should be reversed for disassembly.

5.3.3 Spider slips and elevators should be cleaned frequently, and slips should be kept sharp.

5.3.4 Finding bottom should be accomplished with extreme caution. Do not set tubing down heavily.

5.4 Pulling tubing

5.4.1 A caliper survey prior to pulling a worn string of tubing will provide a quick means of segregating badly worn lengths for removal.

5.4.2 Breakout tongs should be positioned close to the coupling. Hammering the coupling to break the joint is an injurious practice. When tapping is required, use the flat face, never the peen face, of the hammer, and tap lightly at the middle and completely around the coupling, never near the end or on opposite sides only.

5.4.3 Great care should be exercised to disengage all of the thread before lifting the tubing out of the coupling. Do not jump tubing out of the coupling.

5.4.4 Tubing stacked in the derrick should be set on a firm wooden platform and without the bottom thread protector since the design of most protectors is not such as to support the joint or stand without damage to the field thread.

5.4.5 Protect threads from dirt or injury when the tubing is out of the hole.

5.4.6 Tubing set back in the derrick should be properly supported to prevent undue bending. Tubing 60,3 mm (2 3/8-in) OD and larger preferably should be pulled in stands approximately 18,3 m (60 ft) long or in doubles of range 2. Stands of tubing 48,3 mm (1,9-in) OD or smaller and stands longer than 18,3 m (60 ft) should have intermediate support.

5.4.7 Before leaving a location, always firmly tie a setback of tubing in place.

5.4.8 Make sure threads are undamaged, clean and well coated with compound before rerunning.

5.4.9 Distribute joint and tubing wear by moving a length from the top of the string to the bottom each time the tubing is pulled.

5.4.10 In order to avoid leaks, all joints should be retightened occasionally.

5.4.11 When tubing is stuck, the best practice is to use a calibrated weight indicator. Do not be misled, by stretching of the tubing string, into the assumption that the tubing is free.

5.4.12 After a hard pull to loosen a string of tubing, all joints pulled on should be retightened.

5.4.13 All threads should be cleaned and lubricated or should be coated with a material that will minimize corrosion. Clean protectors should be placed on the tubing before it is laid down.

5.4.14 Before tubing is stored or reused, pipe and threads should be inspected and defective joints marked for shopping and regauging.

5.4.15 When tubing is being retrieved because of a tubing failure, it is imperative to future prevention of such failures that a thorough metallurgical study be made. Every attempt should be made to retrieve the failed portion in the "as-failed" condition. When thorough metallurgical analysis reveals some facet of pipe quality to be involved in the failure, the results of the study should be reported.

5.5 Causes of tubing trouble

5.5.1 The most common causes of tubing trouble are listed in 5.5.2 to 5.5.16.

5.5.2 Improper selection for the strength and life required, especially of nonupset tubing where upset tubing should be used.

5.5.3 Insufficient inspection of finished product at the mill or in the yard.

5.5.4 Careless loading, unloading or cartage.

5.5.5 Damaged threads resulting from protectors loosening and falling off.

5.5.6 Lack of care in storage to give proper protection.

5.5.7 Excessive hammering on couplings.

5.5.8 Use of worn-out or wrong types of handling equipment, spiders, tongs, dies or pipe wrenches.

5.5.9 Nonobservance of proper rules in running or pulling tubing.

5.5.10 Coupling wear or rod cutting.

5.5.11 Excessive sucker rod breakage.

5.5.12 Fatigue, which often causes failure at the last engaged thread. There is no positive remedy, but using external-upset tubing in place of nonupset tubing greatly delays the start of this trouble.

5.5.13 Replacement of worn couplings with out-of-specification couplings.

5.5.14 Dropping a string, even a short distance. This may loosen the couplings at the bottom of the string. The string should be pulled and rerun, examining all joints very carefully.

5.5.15 Leaking joints, under external or internal pressure, are a common cause of trouble, and may be due to the following:

a) improper thread compound and/or improper application;

b) dirty threads, or threads contaminated with coating material used as protection from corrosion;

c) undertonging or overtonging;

d) galled threads due to dirt, careless stabbing, damaged threads or poor or diluted thread compound;

e) improperly cut field threads;

f) couplings that have been dented by hammering;

g) pulling too hard on the string;

h) excessive rerunning.

5.5.16 Corrosion, in which both the inside and outside of tubing can be damaged. The damage is generally in the form of pitting, box wear, stress-corrosion cracking and sulfide stress cracking, but localized attack like corrosion-erosion, ringworm and caliper tracks can also occur. Pitting and wear by the sucker rod box can be determined visually by caliper surveys. Cracking may require aids, such as magnetic powder, for detection. Corrosion products may or may not adhere to the pipe walls. Corrosion is generally due to the corrosive well fluid but may be aggravated by the abrasive effects of pumping equipment, by gas lifting or by high velocities. Corrosion can also be influenced by dissimilar metals in close proximity to each other (bimetallic corrosion) and by variations in grain structure, surface conditions and deposits (concentration cell corrosion). Since corrosion may result from many causes and influences and take different forms, no simple or universal remedy can be given for control. Each corrosion problem must be treated individually and a solution attempted in light of the known corrosion factors and operating conditions.

Where internal or external tubing corrosion is known to exist and corrosive fluids are being produced, the following measures can be employed.

a) In flowing wells, the annulus can be packed off and the corrosive fluid confined to the inside of the tubing. The inside of tubing can be protected with special liners, coatings or inhibitors. Under severe conditions, special-alloy steel or glass-reinforced plastics may be used. Alloys do not always eliminate corrosion. When H_2S is present in the well fluids, tubing of high yield strength may be subject to sulfide-corrosion cracking. The concentration of H_2S necessary to cause cracking in different strength materials is not yet well defined. Literature on sulfide corrosion or persons competent in this field should be consulted.

b) In pumping and gas-lift wells, inhibitors introduced via the casing-tubing annulus afford appreciable protection. In this type of completion, especially in pumping wells, better operating practices can also aid in extending the life of tubing, such as through the use of rod protectors, rotation of tubing, and longer and slower pumping strokes.

To determine the value and effectiveness of the above practices and measures, cost and equipment-failure records can be compared before and after application of control measures. Inhibitor effectiveness can also be checked by means of coupons, caliper surveys and visual examinations of readily accessible pieces of equipment. Water analyses to determine the iron content before and after starting the inhibitor treatment may also serve as an indication of the comparative rates of corrosion. When lacking previous experience with any of the above measures, they should be used cautiously and on a limited scale until appraised for the particular operating conditions.

In general, all new areas should be considered as being potentially corrosive and investigations should be initiated early in the life of a field, and repeated periodically, to detect and localize corrosion before it has caused any destructive damage. These investigations should cover the following:

a) an analysis for carbon dioxide and hydrogen sulfide of the gas produced. Also desirable is an analysis of the effluent water for pH, iron content, organic acids, total chlorides and other substances believed to influence the individual problem;

b) corrosion rate tests by using coupons of the same materials as in the well;

c) the use of caliper or optical-instrument inspections.

Where conditions favorable to corrosion exist, a qualified corrosion engineer should be consulted. Particular attention should be given to mitigation of corrosion where the probable life of subsurface equipment is less than the time expected to deplete a well.

6 Transportation, handling and storage

6.1 General

Tubular goods in general, and threads in particular, are made with such precision that they require careful handling, and, whether new, used or reconditioned, they should always be handled with thread protectors in place.

6.2 Transportation

6.2.1 Water transportation

Pipe suppliers or their agents should provide proper supervision at the time of loading and unloading of water carriers to guard against improper or insufficient dunnage, inadequate bracing to prevent shifting during lurching of the ship, stowing pipe in or adjacent to bilge water, injurious chemicals or other corrosive material, dragging pipe along the pile and permitting couplings or thread protectors to hook together or strike the edge of a hatch opening or bump against the ship's rail.

6.2.2 Railroad transportation

When loading pipe on freight cars, in addition to U.S. Interstate Commerce Commission requirements, wooden stringers should be provided across the bottom of the car to provide suitable support for pipe, to allow space for lifting and to keep pipe away from dirt. If the bottom of the car is uneven, the stringers should be rigidly shimmed so that their tops will be in the same plane. Stringers should not be placed under couplings or the upset part of pipe. The load should be tied down and properly bulkheaded to keep it from shifting.

6.2.3 Truck transportation

The following precautions should be taken for truck transportation.

a) Load pipe on bolsters and tie down with suitable chain at the bolsters. In hauling long pipe, an additional chain should be provided in the middle.

b) Load pipe with all couplings on the same end of the truck.

c) Do not overload the truck to the point where there is any danger that the load cannot be delivered to its destination without unloading.

d) After the load has been hauled a short distance, retighten load-binding chains loosened as a result of the load settling.

6.3 Handling

The following precautions should be observed in handling casing and tubing.

a) Before loading or unloading, make sure that the thread protectors are tightly in place. Do not unload pipe by dropping. Avoid rough handling which might damage the threads or dent the body of the pipe. Damaged threads may leak or part. Dents and out-of-roundness may reduce the collapse resistance of the pipe.

   Special handling may be required for sour service and CRA material. Impact against adjacent pipe or other objects may cause a local increase in the hardness of the pipe to the extent that it becomes susceptible to sulfide stress cracking. Contact the owner for any special handling requirements prior to moving or handling.

b) When unloading by hand, use rope slings to control the pipe. When rolling down skids, roll the pipe parallel to the stack and do not allow the pipe to gather momentum or to strike the ends, because even with protectors in place there is danger of damaging the threads. When rolling pipe, on the rack, keep the pipes parallel and do not allow the pipes to gather momentum or to strike the ends.

c) When using a crane, the use of a spreader-bar with a choker-sling or slings at each end is the recommended method of handling long pipe. Each choker-sling shall be double wrapped.

6.4 Storage

The following precautions are recommended for pipe storage.

a) Do not pile pipe directly on the ground, rails or steel or concrete floors. The first tier of pipe should be no less than 500 mm (18 in) from the ground to keep moisture and dirt away from the pipe.

b) Pipe should rest on supports properly spaced to prevent bending of the pipe or damage to the threads. The stringers should lie in the same plane and be reasonably level and should be supported by piers adequate to carry the full stack load without settling.

c) Provide wooden strips as separators between successive layers of pipe so that no weight rests on the couplings. Use at least three spacing strips.

d) Place spacing strips at right angles to pipe and directly above the lower strips and supports to prevent bending of the pipe.

e) Stagger adjoining lengths of pipe in the tiers by an amount approximating to the length of the coupling.

f) Block pipe by nailing blocks at both ends of the spacing strips.

g) For purposes of safety, ease of inspection and handling, pipe should not be stacked higher than 3 m (10 ft). Pipe should not be stacked higher than five tiers at the rig.

h) Pipe in storage should be inspected periodically and protective coatings applied when necessary to arrest corrosion.

7 Inspection and classification of used casing and tubing

7.1 General

Inspection standards and classification for used casing and tubing have been established and the procedures are outlined in this clause.

7.2 Inspection and classification procedures

7.2.1 Inspection capability

Currently accepted methods of inspecting the body section of a pipe are visual, mechanical gauging, electromagnetic, eddy current, ultrasonic and gamma-ray. These inspection techniques are limited to location of cracks, pits and other surface imperfections. Service-induced defects considered to be representative of defects associated with used pipe inspection are as follows: outside and inside corrosion damage; inside-surface wireline (longitudinal) damage; outside transverse and longitudinal slip and tong cuts; inside-surface drill-pipe wear (casing only); transverse cracking (work tubing only); and inside-surface sucker-rod wear (tubing only).

7.2.2 Measurement of pipe wall (minimum wall)

The only acceptable wall thickness measurements are those made with pipe wall micrometers, sonic pulse-echo instruments or gamma-ray devices that the operator can demonstrate to be within 2 % accuracy by use of test blocks sized to approximate to pipe wall thickness.

7.2.3 Procedure

Used casing and tubing should be classified according to the loss of nominal wall thickness listed in Table 4.

These percentages represent reductions in the body wall from the specified pipe wall thickness. This loss of wall thickness affects the body areas along the inside and/or outside surfaces. Pipe with loss of wall thickness in the threaded portion and/or upset section, whether threaded and coupled EUE or integral joint, is not classified in accordance with Table 4. Loss of wall thickness in the heavier upset sections could be permitted to a higher percentage without penalty, depending on the intended service. Damage and/or wall reduction affecting the threaded ends of pipe require individual consideration, depending on the anticipated service, by the owner of the pipe.

In addition to the body wall loss classification shown in Table 4, a colour code identification system used to denote the conditions is provided in Table 5. The colour coding should consist of a paint band of the appropriate colour approximately 50 mm (2 in) wide around the body of the pipe approximately 300 mm (1 ft) from the box end.

7.2.4 Performance properties

Performance properties of new casing, tubing and drill pipe are usually based on equations in ISO 10400 or API Bulletin 5C3. However, there is no standard method for calculating performance properties of used casing and tubing. API Recommended Practice 7G, *Drill Stem Design and Operating Limits*, provides a recommended practice for calculating performance properties of used drill pipe. Drill-pipe wear usually occurs on the outside surface and, consequently, the performance properties of used drill pipe are based on a constant ID, and the wall thickness and OD vary with the degree of wear.

Casing and tubing wear (metal loss) and corrosion usually occur on the inside surface. Performance properties should be based on a constant OD. If external corrosion is evident, it shall also be taken into account. Small pits or other localized metal loss may not be damaging, depending on the application of the pipe, but this type of metal loss should be considered and evaluated by the pipe owner.

If cracks are detected in a length of pipe during inspection and are verified to be of sufficient length to be identified by either visual, optical or magnetic-particle inspection, this joint shall be rejected and considered unfit for further service.

7.3 Pipe wall and threaded-joint conditions

7.3.1 General

The following general comments concern loss of pipe wall thickness and conditions of the threaded joint.

7.3.2 Pipe wall

Metal losses in used casing and tubing usually occur on the inside surface and range in character from isolated pits, gouges or cuts to massive reductions caused by mechanical wear or sand cutting. Wear occurs inside casing and liners by rotation and movement of the drill string while drilling. Wear occurs inside the casing even though rubber protectors are applied to the drill pipe. The amount of wear increases with the length of time the casing is drilled through. Frequently, wear occurs on only one side, that being the casing on the low side of the hole. The performance properties can be calculated by using the remaining wall thickness. Some experience has shown that wire-line wear has a greater effect than drill-pipe wear on burst rating, and it has been suggested that burst pressures be reduced if wall reduction is caused by wire-line wear.

The type of metal loss may influence the application of used casing and tubing. Pipe with pits may not be used under some corrosive conditions but may perform satisfactorily where corrosion is not a factor. Pipe having more uniform metal loss from mechanical wear should be less vulnerable to corrosive conditions and needs only to be derated to the minimum remaining wall thickness.

7.3.3 Threads

When inspecting threads on used casing and tubing, one should check for the following: pulled round threads, galling and fatigue cracks in the last engaged thread. A fast thread lead at the area of last thread engagement of round threads would indicate that the threads became stretched when pulled at loads exceeding the yield strength of the connection. They may make into a coupling on the next makeup but would not have the anticipated joint strength and could have inadequate leak resistance. Galling is always a possibility that may be encountered while breaking out connections, particularly when backups are placed on the coupling. Also, on repeated makeup the threads make up more each time and interference occurs. Work tubing and strings subjected to reciprocal tension stress often develop fatigue cracks at the root of the last engaged thread that could reduce tension values or propagate to joint failure during further use. These situations would require shopping of the threads to restore the length to usable status. It should not be expected that threaded connections gauge properly after being made up power-tight, therefore minor deviations from the specified tolerances should be accepted.

7.3.4 Pin cone reduction

Tubing that has made multiple round trips in the hole, as in the case of work strings, may have pins reduced in diameter due to successive yielding by repeated makeups. This condition may penalize joint strength and leak resistance and, in severe cases, lead to abutment of pin ends near the centre of the coupling in the made-up connection.

7.4 Service rating

Final rating of a length of pipe for further service requires consideration of the ID wall condition and remaining wall thickness to evaluate resistance of the body to collapse, burst and tension; consideration of the thread condition to evaluate resistance to leaks; and consideration of the pin cone to evaluate makeup.

Depending on circumstances and emergency needs, gauging of the threads may be considered along with the usual wall inspection to determine final performance properties. Utilization of the used casing or tubing should be based on experience and judgment with respect to well conditions and environmental factors.

8 Reconditioning

Tubular goods that have become damaged through use or abuse may often be reconditioned to advantage. This should be done only in accordance with ISO 11960 or API Specification 5CT. The acceptability of reconditioned threads should always be confirmed by gauging and inspection in accordance with ISO 10422 or API Specification 5B.

9 Field welding of attachments on casing

9.1 General

9.1.1 The selection of the steel for use in casing is governed by important considerations dictated by the service the casing has to perform. Steels most suitable for field welding do not have these performance properties. Therefore, field weldability shall not be of primary consideration in the selection of steel for the manufacture of casing. As a result, unless precautions are taken welding may have adverse effects on many of the steels used in all grades of casing, especially J-55 and higher.

9.1.2 The heat from welding may affect the mechanical properties of high-strength casing steels. Cracks and brittle areas are likely to develop in the heat-affected zone. Hard areas or cracks may cause failure, especially when the casing is subjected to tool-joint battering. For these reasons, welding on high-strength casing should be avoided if possible.

9.1.3 Practices and equipment that will eliminate welding are recommended. For example, cement or locking attachments might be used rather than welding bottom joints to prevent them from unscrewing. Similarly, use of mechanical means for attachment of centralizers and scratchers is encouraged.

9.1.4 Although welding on high-strength casing is not recommended as the best practice, it is recognized that under certain circumstances the user may elect to do so. In such cases, there are certain practices that, if followed, will minimize the deleterious effects of welding. The intent here is to outline practices that will serve as a guide to field personnel.

9.1.5 Welding is not recommended on those critical portions of the casing string where tension, burst or collapse-strength properties shall not be impaired. If welding is necessary, it should be restricted to the lowermost portions of the cemented interval at the bottom of the casing string. Shoe-joint welding of couplings, when necessary, should be used with extreme caution and with full use of procedures outlined herein.

9.1.6 The responsibility for welding lies with the user, and results are largely governed by the welder's skill. Weldability of the various types and grades of casing varies widely, thus placing added responsibility on the welder. Transporting a qualified welder to the job rather than using a less skilled man who may be at hand will in most cases prove economical. The responsible operating representative should ascertain the welder's qualifications and, if necessary, assure himself by instruction or demonstration that the welder is able to perform the work satisfactorily.

9.2 Requirements for welds

9.2.1 Welds should have sufficient mechanical strength to prevent joints from backing off or to hold various attachments to the casing. In-service welds are called upon to withstand impact, pounding, vibration and other severe service conditions to which casing is subjected. Ability to withstand bending forces is often also important. To accomplish this, ductile welds free from cracks and brittle or hard spots are desired.

9.2.2 Leak resistance is not a factor in welds covered by procedures outlined herein. The purpose of the welds is to make attachments or to prevent joints from unscrewing. Where welding is done on joints, the weld shall not be intended as a seal to prevent leakage but rather as a means of preventing the joint from backing off. Leak resistance is obtained by the joint itself.

9.2.3 Leak resistance is required for the seal weld in casing hangers.

9.3 Processes

Welding is currently being done by the metal-arc or oxyacetylene processes. Brazing alloys melting at 650 °C (1 200 °F) or lower, which possess good mechanical properties, are available for application by an oxyacetylene or oxypropane torch. They may be used to avoid brittle areas or cracks that may occur in alloy casing when welded but, when so subjected to this temperature, a reduction in strength may result.

9.4 Filler for arc welding

When using the metal-arc process, low-hydrogen electrodes should be used. These include all electrodes with the AWS classifications Exx 15, Exx 16 and Exx 18 in AWS Specification A5.1. Low-hydrogen electrodes should not be exposed to the atmosphere until ready for use. Electrodes shall be stored in holding ovens at 65 °C to 150 °C (150 °F to 300 °F) immediately after their containers have been opened. Once removed from the holding oven, electrodes shall be used within 30 min. Electrodes not used within this time limit shall be discarded or reconditioned by baking at 315 °C to 370 °C (600 °F to 700 °F) for 1 h. After reconditioning, electrodes shall be placed in the holding oven.

9.5 Preparation of base metal

The area to be welded should be dry and brushed or wiped free of any excess paint, grease, scale, rust or dirt.

9.6 Preheating and cooling

9.6.1 Preheating is considered essential for welding all grades of casing. At least 75 mm (3 in) on each side of weld locations should be preheated to 205 °C to 315 °C (400 °F to 600 °F). The preheat temperature should be maintained during welding. (Use a "Tempilstik" or equivalent temperature-sensitive crayon to check temperature.)

9.6.2 Rapid cooling should be avoided. To ensure slow cooling, welds should be protected from extreme weather conditions (cold, rain, high winds, etc.). Welds made on the casing as it is being run should be cooled in air to below 120 °C (250 °F) (measured with a "Tempilstik" or equivalent) prior to lowering the weld into the hole. The required cooling usually takes about 5 min.

9.7 Welding technique

9.7.1 The weld should be started as soon as the specified preheat temperature has been attained. The welding operation should be shielded from strong winds, blowing dust and sand, and rain.

9.7.2 Where metal-arc welding is used, electrodes 4,8 mm (3/16-in) in diameter or smaller should be used. Two-pass welds are preferred, provided the second pass can be controlled so that it overlays only the weld metal and not extend to the casing. The function of the second pass is to temper or anneal the underlying weld and adjacent metal. This purpose is defeated if the second pass extends onto the casing. The second pass should be laid on very quickly after cleaning the first bead so as to prevent the metal heated by the first pass from cooling quickly enough to become brittle. Weaving should be kept to a minimum, and the current should be on the low side of the range recommended by the electrode manufacturer. Every effort should be made to avoid undercutting.

9.7.3 All slag and flux remaining on any welding bead should be removed by chipping or grinding before depositing the next bead.

9.7.4 Attachments should fit as closely as possible to the casing surface.

9.7.5 The arc should not be struck on the casing, as every arc burn results in a hard spot and damage to the casing. Cracks have frequently resulted from striking the arc on the casing. The arc should be struck on the attachment, which is made of steel not as susceptible to damage. If it is really necessary to strike the arc on the casing, it should be struck in the area to be welded.

9.7.6 Care should be taken to ensure that the welding cable is properly grounded to the casing, but ground wire should not be welded to the casing. Ground wire should be firmly clamped to the casing or fixed in position between pipe slips. Bad contact may cause sparking, with resultant hard spots beneath which incipient cracks may develop. The welding cable should not be grounded to a steel derrick, rotary-table base or casing rack.

9.7.7 As much welding as possible should be done on the rack rather than on the rig floor or while the casing is hanging in the well. This procedure has two advantage: (a) the welding can carried out under more favourable conditions and (b) the weld cooling rate can be slower and more closely controlled. Do not ground to the rack but firmly clamp to the casing being welded.

9.7.8 If couplings, float collars and guide shoes are welded, sufficient metal should be deposited to prevent them from backing out. If the top side of the float collar and casing collars are welded while the casing is in the rotary or if the practice is not to make a complete weld, three 75 mm (3-in) welds should be placed at 120° intervals around 244,5 mm (9 5/8-in) casing; three 100 mm (4-in) welds should be placed on larger casing; and three 50 mm (2-in) welds on smaller casing.

9.7.9 If welds longer than 100 mm (4 in) to150 mm (6 in) are made, backstepping is advantageous. For example, if 150 mm (6 in) of weld have been deposited as a stringer bead from left to right, then the operator should start about 150 mm (6 in) to the left of the weld deposited and weld up to the starting point of the previously deposited weld.

9.7.10 Complete fillet welds should have approximately equal leg dimensions. Care should be taken to avoid undercutting. Two passes are preferred. (Welds should be cleaned between passes.)

9.7.11 When lugs are welded to casing, the weld should extend around the lug ends. It is good practice to strike the arc near the lug end, weld the end and bring the weld back to about the lug centre. The arc is momentarily broken so that the lug can be cut or burnt to length and the unwelded end hammered down against the casing. The weld is then continued around the second end, bringing the arc back on the weld before breaking. In this manner, ends are welded without either striking or breaking the arc at the ends.

9.7.12 When centralizers and scratchers are welded to casing, welds should be a minimum length of 50 mm (2 in) and at 50 mm (2-in) intervals.

9.7.13 When rotating scratchers are welded to casing, full-length welds on each end, with 19 mm (3/4-in) welds at two equal spacings on the front edge and one 19 mm (3/4-in) weld on the centre of the rear or trailing edge, have been found satisfactory.

Table 1 — Casing makeup torque guidelines — 8-round-thread casing

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
114,3	4,500	9,50	H-40	ST&C	1 040	770
114,3	4,500	9,50	J-55	ST&C	1 380	1 010
114,3	4,500	10,50	J-55	ST&C	1 790	1 320
114,3	4,500	11,60	J-55	ST&C	2 090	1 540
114,3	4,500	9,50	K-55	ST&C	1 520	1 120
114,3	4,500	10,50	K-55	ST&C	1 980	1 460
114,3	4,500	11,60	K-55	ST&C	2 310	1 700
114,3	4,500	11,60	J-55	LT&C	2 200	1 620
114,3	4,500	11,60	K-55	LT&C	2 430	1 800
114,3	4,500	11,60	C-75	LT&C	2 910	2 150
114,3	4,500	13,50	C-75	LT&C	3 530	2 600
114,3	4,500	11,60	L-80	LT&C	3 030	2 230
114,3	4,500	13,50	L-80	LT&C	3 670	2 710
114,3	4,500	11,60	N-80	LT&C	3 090	2 280
114,3	4,500	13,50	N-80	LT&C	3 740	2 760
114,3	4,500	11,60	C-90	LT&C	3 320	2 450
114,3	4,500	13,50	C-90	LT&C	4 030	2 970
114,3	4,500	11,60	C-95	LT&C	3 500	2 580
114,3	4,500	13,50	C-95	LT&C	4 240	3 130
114,3	4,500	11,60	P-110	LT&C	4 100	3 020
114,3	4,500	13,50	P-110	LT&C	4 960	3 660
114,3	4,500	15,10	P-110	LT&C	5 960	4 400
114,3	4,500	15,10	Q-125	LT&C	6 650	4 910
127,0	5,000	11,50	J-55	ST&C	1 810	1 330
127,0	5,000	13,00	J-55	ST&C	2 290	1 690
127,0	5,000	15,00	J-55	ST&C	2 800	2 070
127,0	5,000	11,50	K-55	ST&C	1 990	1 470
127,0	5,000	13,00	K-55	ST&C	2 520	1 860

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
127,0	5,000	15,00	K-55	ST&C	3 090	2 280
127,0	5,000	13,00	J-55	LT&C	2 470	1 820
127,0	5,000	15,00	J-55	LT&C	3 020	2 230
127,0	5,000	13,00	K-55	LT&C	2 730	2 010
127,0	5,000	15,00	K-55	LT&C	3 340	2 460
127,0	5,000	15,00	C-75	LT&C	4 010	2 960
127,0	5,000	18,00	C-75	LT&C	5 110	3 770
127,0	5,000	21,40	C-75	LT&C	6 320	4 660
127,0	5,000	24,10	C-75	LT&C	7 310	5 390
127,0	5,000	15,00	L-80	LT&C	4 170	3 080
127,0	5,000	18,00	L-80	LT&C	5 320	3 930
127,0	5,000	21,40	L-80	LT&C	6 590	4 860
127,0	5,000	24,10	L-80	LT&C	7 610	5 610
127,0	5,000	15,00	N-80	LT&C	4 250	3 140
127,0	5,000	18,00	N-80	LT&C	5 420	4 000
127,0	5,000	21,40	N-80	LT&C	6 710	4 950
127,0	5,000	24,10	N-80	LT&C	7 760	5 720
127,0	5,000	15,00	C-90	LT&C	4 590	3 380
127,0	5,000	18,00	C-90	LT&C	5 850	4 310
127,0	5,000	21,40	C-90	LT&C	7 240	5 340
127,0	5,000	23,20	C-90	LT&C	7 980	5 880
127,0	5,000	24,10	C-90	LT&C	8 370	6 170
127,0	5,000	15,00	C-95	LT&C	4 830	3 560
127,0	5,000	18,00	C-95	LT&C	6 160	4 550
127,0	5,000	21,40	C-95	LT&C	7 630	5 620
127,0	5,000	24,10	C-95	LT&C	8 810	6 500
127,0	5,000	14,00	H-40	ST&C	1 760	1 300
139,7	5,500	14,00	J-55	ST&C	2 330	1 720
139,7	5,500	15,50	J-55	ST&C	2 730	2 020
139,7	5,500	17,00	J-55	ST&C	3 110	2 290
139,7	5,500	14,00	K-55	ST&C	2 560	1 890
139,7	5,500	15,50	K-55	ST&C	3 000	2 220
139,7	5,500	17,00	K-55	ST&C	3 410	2 520
139,7	5,500	15,50	J-55	LT&C	2 940	2 170

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
139,7	5,500	17,00	J-55	LT&C	3 340	2 470
139,7	5,500	15,50	K-55	LT&C	3 240	2 390
139,7	5,500	17,00	K-55	LT&C	3 680	2 720
139,7	5,500	17,00	C-75	LT&C	4 440	3 270
139,7	5,500	20,00	C-75	LT&C	5 460	4 030
139,7	5,500	23,00	C-75	LT&C	6 410	4 730
139,7	5,500	17,00	L-80	LT&C	4 630	3 410
139,7	5,500	20,00	L-80	LT&C	5 700	4 200
139,7	5,500	23,00	L-80	LT&C	6 690	4 930
139,7	5,500	17,00	N-80	LT&C	4 710	3 480
139,7	5,500	20,00	N-80	LT&C	5 800	4 280
139,7	5,500	23,00	N-80	LT&C	6 810	5 020
139,7	5,500	17,00	C-90	LT&C	5 090	3 750
139,7	5,500	20,00	C-90	LT&C	6 270	4 620
139,7	5,500	23,00	C-90	LT&C	7 360	5 430
139,7	5,500	17,00	C-95	LT&C	5 360	3 960
139,7	5,500	20,00	C-95	LT&C	6 600	4 870
139,7	5,500	23,00	C-95	LT&C	7 750	5 720
139,7	5,500	17,00	P-110	LT&C	6 270	4 620
139,7	5,500	20,00	P-110	LT&C	7 720	5 690
139,7	5,500	23,00	P-110	LT&C	9 060	6 680
139,7	5,500	23,00	Q-125	LT&C	10 120	7 470
168,3	6,625	20,00	H-40	ST&C	2 490	1 840
168,3	6,625	20,00	J-55	ST&C	3 320	2 450
168,3	6,625	24,00	J-55	ST&C	4 250	3 140
168,3	6,625	20,00	K-55	ST&C	3 620	2 670
168,3	6,625	24,00	K-55	ST&C	4 640	3 420
168,3	6,625	20,00	J-55	LT&C	3 600	2 660
168,3	6,625	24,00	J-55	LT&C	4 620	3 400
168,3	6,625	20,00	K-55	LT&C	3 940	2 900
168,3	6,625	24,00	K-55	LT&C	5 050	3 720

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
168,3	6,625	24,00	C-75	LT&C	6 140	4 530
168,3	6,625	28,00	C-75	LT&C	7 480	5 520
168,3	6,625	32,00	C-75	LT&C	8 650	6 380
168,3	6,625	24,00	L-80	LT&C	6 410	4 730
168,3	6,625	28,00	L-80	LT&C	7 810	5 760
168,3	6,625	32,00	L-80	LT&C	9 030	6 660
168,3	6,625	24,00	N-80	LT&C	6 520	4 810
168,3	6,625	28,00	N-80	LT&C	7 940	5 860
168,3	6,625	32,00	N-80	LT&C	9 190	6 780
168,3	6,625	24,00	C-90	LT&C	7 060	5 210
168,3	6,625	28,00	C-90	LT&C	8 610	6 350
168,3	6,625	32,00	C-90	LT&C	9 950	7 340
168,3	6,625	24,00	C-95	LT&C	7 440	5 490
168,3	6,625	28,00	C-95	LT&C	9 070	6 690
168,3	6,625	32,00	C-95	LT&C	10 490	7 740
168,3	6,625	24,00	P-110	LT&C	8 690	6 410
168,3	6,625	28,00	P-110	LT&C	10 590	7 810
168,3	6,625	32,00	P-110	LT&C	12 250	9 040
168,3	6,625	32,00	Q-125	LT&C	13 710	10 110
177,8	7,000	17,00	H-40	ST&C	1 650	1 220
177,8	7,000	20,00	H-40	ST&C	2 380	1 760
177,8	7,000	20,00	J-55	ST&C	3 170	2 340
177,8	7,000	23,00	J-55	ST&C	3 850	2 840
177,8	7,000	26,00	J-55	ST&C	4 530	3 340
177,8	7,000	20,00	K-55	ST&C	3 450	2 540
177,8	7,000	23,00	K-55	ST&C	4 190	3 090
177,8	7,000	26,00	K-55	ST&C	4 930	3 640
177,8	7,000	23,00	J-55	LT&C	4 240	3 130
177,8	7,000	26,00	J-55	LT&C	4 980	3 670
177,8	7,0000	23,00	K-55	LT&C	4 630	3 410
177,8	7,000	26,00	K-55	LT&C	5 440	4 010
177,8	7,000	23,00	C-75	LT&C	5 640	4 160
177,8	7,000	26,00	C-75	LT&C	6 630	4 890

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
177,8	7,000	29,00	C-75	LT&C	7 620	5 620
177,8	7,000	32,00	C-75	LT&C	8 580	6 330
177,8	7,000	35,00	C-75	LT&C	9 530	7 030
177,8	7,000	38,00	C-75	LT&C	10 400	7 670
177,8	7,000	23,00	L-80	LT&C	5 890	4 350
177,8	7,000	26,00	L-80	LT&C	6 930	5 110
177,8	7,000	29,00	L-80	LT&C	7 960	5 870
177,8	7,000	32,00	L-80	LT&C	8 970	6 610
177,8	7,000	35,00	L-80	LT&C	9 950	7 340
177,8	7,000	38,00	L-80	LT&C	10 860	8 010
177,8	7,000	23,00	N-80	LT&C	5 990	4 420
177,8	7,000	26,00	N-80	LT&C	7 040	5 190
177,8	7,000	29,00	N-80	LT&C	8 100	5 970
177,8	7,000	32,00	N-80	LT&C	9 110	6 720
177,8	7,000	35,00	N-80	LT&C	10 120	7 460
177,8	7,000	38,00	N-80	LT&C	11 040	8 140
177,8	7,000	23,00	C-90	LT&C	6 500	4 790
177,8	7,000	26,00	C-90	LT&C	7 630	5 630
177,8	7,000	29,00	C-90	LT&C	8 780	6 480
177,8	7,000	32,00	C-90	LT&C	9 880	7 290
177,8	7,000	35,00	C-90	LT&C	10 970	8 090
177,8	7,000	38,00	C-90	LT&C	11 970	8 830
177,8	7,000	23,00	C-95	LT&C	6 850	5 050
177,8	7,000	26,00	C-95	LT&C	8 050	5 930
177,8	7,000	29,00	C-95	LT&C	9 250	6 830
177,8	7,000	32,00	C-95	LT&C	10 420	7 680
177,8	7,000	35,00	C-95	LT&C	11 560	8 530
177,8	7,000	38,00	C-95	LT&C	12 620	9 310
177,8	7,000	26,00	P-110	LT&C	9 390	6 930
177,8	7,000	29,00	P-110	LT&C	10 800	7 970
177,8	7,000	32,00	P-110	LT&C	12 160	8 970
177,8	7,000	35,00	P-110	LT&C	13 500	9 960
177,8	7,000	38,00	P-110	LT&C	14 730	10 870
177,8	7,000	35,00	Q-125	LT&C	15 110	11 150
177,8	7,000	38,00	Q-125	LT&C	16 490	12 160
193,7	7,625	24,00	H-40	ST&C	2 870	2 120
193,7	7,625	26,40	J-55	ST&C	4 270	3 150

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
193,7	7,625	26,40	K-55	ST&C	4 640	3 420
193,7	7,625	26,40	J-55	LT&C	4 690	3 460
193,7	7,625	26,40	K-55	LT&C	5 110	3 770
193,7	7,625	26,40	C-75	LT&C	6 250	4 610
193,7	7,625	29,70	C-75	LT&C	7 340	5 420
193,7	7,625	33,70	C-75	LT&C	8 610	6 350
193,7	7,625	39,00	C-75	LT&C	10 190	7 510
193,7	7,625	42,80	C-75	LT&C	11 560	8 520
193,7	7,625	47,10	C-75	LT&C	12 920	9 530
193,7	7,625	26,40	L-80	LT&C	6 530	4 820
193,7	7,625	29,70	L-80	LT&C	7 680	5 670
193,7	7,625	33,70	L-80	LT&C	9 000	6 640
193,7	7,625	39,00	L-80	LT&C	10 650	7 860
193,7	7,625	42,80	L-80	LT&C	12 090	8 910
193,7	7,625	47,10	L-80	LT&C	13 520	9 970
193,7	7,625	26,40	N-80	LT&C	6 640	4 900
193,7	7,625	29,70	N-80	LT&C	7 800	5 750
193,7	7,625	33,70	N-80	LT&C	9 140	6 740
193,7	7,625	39,00	N-80	LT&C	10 820	7 980
193,7	7,625	42,80	N-80	LT&C	12 280	9 060
193,7	7,625	47,10	N-80	LT&C	13 730	10 130
193,7	7,625	26,40	C-90	LT&C	7 210	5 320
193,7	7,625	29,70	C-90	LT&C	8 470	6 250
193,7	7,625	33,70	C-90	LT&C	9 930	7 330
193,7	7,625	39,00	C-90	LT&C	11 750	8 670
193,7	7,625	42,80	C-90	LT&C	13 330	9 840
193,7	7,625	45,30	C-90	LT&C	14 160	10 450
193,7	7,625	47,10	C-90	LT&C	14 910	11 000
193,7	7,625	26,40	C-95	LT&C	7 600	5 600
193,7	7,625	29,70	C-95	LT&C	8 930	6 590
193,7	7,625	33,70	C-95	LT&C	10 470	7 720
193,7	7,625	39,00	C-95	LT&C	12 390	9 140
193,7	7,625	42,80	C-95	LT&C	14 050	10 370
193,7	7,625	47,10	C-95	LT&C	15 720	11 590
193,7	7,625	29,70	P-110	LT&C	10 420	7 690
193,7	7,625	33,70	P-110	LT&C	12 220	9 010
193,7	7,625	39,00	P-110	LT&C	14 460	10 660

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
193,7	7,625	42,80	P-110	LT&C	16 400	12 100
193,7	7,625	47,10	P-110	LT&C	18 340	13 530
193,7	7,625	39,00	Q-125	LT&C	16 190	11 940
193,7	7,625	42,80	Q-125	LT&C	18 370	13 550
193,7	7,625	45,30	Q-125	LT&C	19 520	14 390
193,7	7,625	47,10	Q-125	LT&C	20 540	15 150
219,1	8,625	28,00	H-40	ST&C	3 150	2 330
219,1	8,625	32,00	H-40	ST&C	3 780	2 790
219,1	8,625	24,00	J-55	ST&C	3 310	2 440
219,1	8,625	32,00	J-55	ST&C	5 050	3 720
219,1	8,625	36,00	J-55	ST&C	5 880	4 340
219,1	8,625	24,00	K-55	ST&C	3 570	2 630
219,1	8,625	32,00	K-55	ST&C	5 460	4 020
219,1	8,625	36,00	K-55	ST&C	6 350	4 680
219,1	8,625	32,00	J-55	LT&C	5 660	4 170
219,1	8,625	36,00	J-55	LT&C	6 590	4 860
219,1	8,625	32,00	K-55	LT&C	6 130	4 520
219,1	8,625	36,00	K-55	LT&C	7 140	5 260
219,1	8,625	36,00	C-75	LT&C	8 780	6 480
219,1	8,625	40,00	C-75	LT&C	10 060	7 420
219,1	8,625	44,00	C-75	LT&C	11 310	8 340
219,1	8,625	49,00	C-75	LT&C	12 730	9 390
219,1	8,625	36,00	L-80	LT&C	9 190	6 780
219,1	8,625	40,00	L-80	LT&C	10 530	7 760
219,1	8,625	44,00	L-80	LT&C	11 840	8 740
219,1	8,625	49,00	L-80	LT&C	13 320	9 830
219,1	8,625	36,00	N-80	LT&C	9 330	6 880
219,1	8,625	40,00	N-80	LT&C	10 680	7 880
219,1	8,625	44,00	N-80	LT&C	12 020	8 870
219,1	8,625	49,00	N-80	LT&C	13 520	9 970
219,1	8,625	36,00	C-90	LT&C	10 150	7 490
219,1	8,625	40,00	C-90	LT&C	11 630	8 580
219,1	8,625	44,00	C-90	LT&C	13 080	9 650
219,1	8,625	49,00	C-90	LT&C	14 710	10 850
219,1	8,625	36,00	C-95	LT&C	10 700	7 890

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
219,1	8,625	40,00	C-95	LT&C	12 260	9 040
219,1	8,625	44,00	C-95	LT&C	13 790	10 170
219,1	8,625	49,00	C-95	LT&C	15 510	11 440
219,1	8,625	40,00	P-110	LT&C	14 300	10 550
219,1	8,625	44,00	P-110	LT&C	16 090	11 860
219,1	8,625	49,00	P-110	LT&C	18 100	13 350
219,1	8,625	49,00	Q-125	LT&C	20 280	14 960
244,5	9,615	32,30	H-40	ST&C	3 440	2 540
244,5	9,625	36,00	H-40	ST&C	3 990	2 940
244,5	9,625	36,00	J-55	ST&C	5 340	3 940
244,5	9,625	40,00	J-55	ST&C	6 120	4 520
244,5	9,625	36,00	K-55	ST&C	5 740	4 230
244,5	9,625	40,00	K-55	ST&C	6 590	4 860
244,5	9,625	36,00	J-55	LT&C	6 140	4 530
244,5	9,625	40,00	J-55	LT&C	7 050	5 200
244,5	9,625	36,00	K-55	LT&C	6 630	4 890
244,5	9,625	40,00	K-55	LT&C	7 610	5 610
244,5	9,625	40,00	C-75	LT&C	9 410	6 940
244,5	9,625	43,50	C-75	LT&C	10 530	7 760
244,5	9,625	47,00	C-75	LT&C	11 550	8 520
244,5	9,625	53,50	C-75	LT&C	13 540	9 990
244,5	9,625	40,00	L-80	LT&C	9 860	7 270
244,5	9,625	43,50	L-80	LT&C	11 030	8 130
244,5	9,625	47,00	L-80	LT&C	12 100	8 930
244,5	9,625	53,50	L-80	LT&C	14 190	10 470
244,5	9,625	40,00	N-80	LT&C	10 000	7 370
244,5	9,625	43,50	N-80	LT&C	11 190	8 250
244,5	9,625	47,00	N-80	LT&C	12 270	9 050
244,5	9,625	53,50	N-80	LT&C	14 390	10 620
244,5	9,625	40,00	C-90	LT&C	10 900	8 040
244,5	9,625	43,50	C-90	LT&C	12 190	8 990
244,5	9,625	47,00	C-90	LT&C	13 380	9 870
244,5	9,625	53,50	C-90	LT&C	15 690	11 570

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
244,5	9,625	40,00	C-95	LT&C	11 490	8 470
244,5	9,625	43,50	C-95	LT&C	12 850	9 480
244,5	9,625	47,00	C-95	LT&C	14 100	10 400
244,5	9,625	53,50	C-95	LT&C	16 540	12 200
244,5	9,625	43,50	P-110	LT&C	14 980	11 050
244,5	9,625	47,00	P-110	LT&C	16 440	12 130
244,5	9,625	53,50	P-110	LT&C	19 280	14 220
244,5	9,625	47,00	Q-125	LT&C	18 440	13 600
244,5	9,625	53,50	Q-125	LT&C	21 620	15 950
273,1	10,750	32,75	H-40	ST&C	2 790	2 050
273,1	10,750	40,50	H-40	ST&C	4 250	3 140
273,1	10,750	40,50	J-55	ST&C	5 700	4 200
273,1	10,750	45,55	J-55	ST&C	6 680	4 930
273,1	10,750	51,00	J-55	ST&C	7 660	5 650
273,1	10,750	40,50	K-55	ST&C	6 100	4 500
273,1	10,750	45,55	K-55	ST&C	7 160	5 280
273,1	10,750	51,00	K-55	ST&C	8 210	6 060
273,1	10,750	51,00	C-75	ST&C	10 250	7 560
273,1	10,750	55,50	C-75	ST&C	11 420	8 420
273,1	10,750	51,00	L-80	ST&C	10 760	7 940
273,1	10,750	55,50	L-80	ST&C	11 990	8 840
273,1	10,750	51,00	N-80	ST&C	10 900	8 040
273,1	10,750	55,50	N-80	ST&C	12 140	8 950
273,1	10,750	51,00	C-90	ST&C	11 920	8 790
273,1	10,750	55,50	C-90	ST&C	13 270	9 790
273,1	10,750	51,00	C-95	ST&C	12 560	9 270
273,1	10,750	55,50	C-95	ST&C	13 990	10 320
273,1	10,750	51,00	P-110	ST&C	14 630	10 790
273,1	10,750	55,50	P-110	ST&C	16 300	12 020
273,1	10,750	60,70	P-110	ST&C	18 130	13 370
273,1	10,750	65,70	P-110	ST&C	19 950	14 710
273,1	10,750	60,70	Q-125	ST&C	20 360	15 020
273,1	10,750	65,70	Q-125	ST&C	22 400	16 520

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
298,5	11,750	42,00	H-40	ST&C	4 170	3 070
298,5	11,750	47,00	J-55	ST&C	6 460	4 770
298,5	11,750	54,00	J-55	ST&C	7 700	5 680
298,5	11,750	60,00	J-55	ST&C	8 800	6 490
298,5	11,750	47,00	K-55	ST&C	6 900	5 090
298,5	11,750	54,00	K-55	ST&C	8 220	6 060
298,5	11,750	60,00	K-55	ST&C	9 400	6 930
298,5	11,750	60,00	C-75	ST&C	11 780	8 690
298,5	11,750	60,00	L-80	ST&C	12 370	9 130
298,5	11,750	60,00	N-80	ST&C	12 420	9 240
298,5	11,750	60,00	C-90	ST&C	13 710	10 110
298,5	11,750	60,00	C-95	ST&C	14 460	10 660
298,5	11,750	60,00	P-110	ST&C	16 830	12 420
298,5	11,750	60,00	Q-125	ST&C	18 920	13 950
339,7	13,375	48,00	H-40	ST&C	4 370	3 220
339,7	13,375	54,50	J-55	ST&C	6 970	5 140
339,7	13,375	61,00	J-55	ST&C	8 070	5 950
339,7	13,375	68,00	J-55	ST&C	9 160	6 750
339,7	13,375	54,50	K-55	ST&C	7 410	5 470
339,7	13,375	61,00	K-55	ST&C	8 580	6 330
339,7	13,375	68,00	K-55	ST&C	9 740	7 180
339,7	13,375	68,00	C-75	ST&C	12 280	9 060
329,7	13,375	72,00	C-75	ST&C	13 260	9 780
339,7	13,375	68,00	L-80	ST&C	12 910	9 520
339,7	13,375	72,00	L-80	ST&C	13 950	10 290
329,7	13,375	68,00	N-80	ST&C	13 060	9 630
339,7	13,375	72,00	N-80	ST&C	14 110	10 400
339,7	13,375	68,00	C-90	ST&C	14 330	10 570
339,7	13,375	72,00	C-90	ST&C	15 480	11 420

Table 1 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
339,7	13,375	68,00	C-95	ST&C	15 110	11 140
339,7	13,375	72,00	C-95	ST&C	16 320	12 040
339,7	13,375	68,00	P-110	ST&C	17 580	12 970
339,7	13,375	72,00	P-110	ST&C	18 990	14 010
339,7	13,375	72,00	Q-125	ST&C	21 370	15 770
406,4	16,000	65,00	H-40	ST&C	5 950	4 390
406,4	16,000	75,00	J-55	ST&C	9 630	7 100
406,4	16,000	84,00	J-55	ST&C	11 080	8 170
406,4	16,000	75,00	K-55	ST&C	10 190	7 520
406,4	16,000	84,00	K-55	ST&C	11 730	8 650
473,0	18,625	87,50	H-40	ST&C	7 580	5 590
473,0	18,625	87,50	J-55	ST&C	10 220	7 540
473,0	18,625	87,50	K-55	ST&C	10 770	7 940
508,0	20,000	94,00	H-40	ST&C	7 870	5 810
508,0	20,000	94,00	J-55	ST&C	10 620	7 830
508,0	20,000	105,50	J-55	ST&C	12 370	9 130
508,0	20,000	133,00	J-55	ST&C	16 160	11 920
508,0	20,000	94,00	K-55	ST&C	11 160	8 230
508,0	20,000	106,50	K-55	ST&C	13 000	9 590
508,0	20,000	133,00	K-55	ST&C	16 980	12 520
508,0	20,000	94,00	J-55	LT&C	12 290	9 070
508,0	20,000	106,50	J-55	LT&C	14 320	10 560
508,0	20,000	133,00	J-55	LT&C	18 700	13 790
508,0	20,000	94,00	K-55	LT&C	12 950	9 550
508,0	20,000	106,50	K-55	LT&C	15 090	11 130
508,0	20,000	133,00	K-55	LT&C	19 700	14 530

NOTE 1 It is recommended that the makeup target be based on position, not torque (see 4.4.1 and 4.4.2).

NOTE 2 Under normal circumstances, and for sizes 13 3/8 in and smaller, variations in the listed torque values of ± 25 % should be considered acceptable.

Table 2 — Torque values for extreme-line casing

Size (outside diameter) in	Torque, ft·lbf			
	J55 and K55	**C75, L80, N80, C90**	**C95, P110**	**Q125**
5	2 700	3 200	3 700	4 200
5 1/2	2 700	3 200	3 700	4 200
6 5/8	3 200	3 700	4 200	4 700
7	3 200	3 700	4 200	4 700
7 5/8	3 700	4 200	4 700	5 200
8 5/8	4 200	4 700	5 200	5 700
9 5/8	4 700	5 200	6 200	6 700
Size (outside diameter) mm	**Torque,** N·m			
	J55 and K55	**C75, L80, N80, C90**	**C95, P110**	**Q125**
127	3 660	4 340	5 020	5 690
139,7	3 660	4 340	5 020	5 690
168,3	4 340	5 020	5 690	6 370
177,8	4 340	5 020	5 690	6 370
193,7	5 020	5 690	6 370	7 050
219,1	5 690	6 370	7 050	7 730
244,5	6 780	7 050	8 410	9 080

NOTE 1 The torque values listed above are recommended for use in conjunction with close visual examination to be sure the shoulder closes and to avoid excessive box swelling.

NOTE 2 The outside shoulder is not a sealing surface; it serves as a stop only.

NOTE 3 Torque values higher than those listed above may be considered under certain conditions, providing box swelling does not occur.

NOTE 4 Increased axial tension stress due to higher torque values could be excessive for sulfide service.

NOTE 5 If the connection does not shoulder when maximum torque is applied, it should be treated as a questionable joint as provided under 4.4.3.

NOTE 6 Recommended makeup torque values for 273,1 mm (10 3/4 in) are not available due to lack of data.

Table 3 — Tubing makeup torque guidelines — Round-thread tubing

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
26,7	1,050	1,14	H-40	NU	190	140
26,7	1,050	1,14	J-55	NU	240	180
26,7	1,050	1,14	C-75	NU	320	230
26,7	1,050	1,14	L-80	NU	330	240
26,7	1,050	1,14	N-80	NU	340	250
26,7	1,050	1,14	C-90	NU	350	260
26,7	1,050	1,20	H-40	EUE	630	460
26,7	1,050	1,20	J-55	EUE	810	600
26,7	1,050	1,20	C-75	EUE	1 060	780
26,7	1,050	1,20	L-80	EUE	1 090	810
26,7	1,050	1,20	N-80	EUE	1 130	830
26,7	1,050	1,20	C-90	EUE	1 190	880
33,4	1,315	1,70	H-40	NU	280	210
33,4	1,315	1,70	J-55	NU	370	270
33,4	1,315	1,70	C-75	NU	480	360
33,4	1,315	1,70	L-80	NU	500	370
33,4	1,315	1,70	N-80	NU	510	380
33,4	1,315	1,70	C-90	NU	540	400
33,4	1,315	1,80	H-40	EUE	590	440
33,4	1,315	1,80	J-55	EUE	770	570
33,4	1,315	1,80	C-75	EUE	1 010	740
33,4	1,315	1,80	L-80	EUE	1 040	760
33,4	1,315	1,80	N-80	EUE	1 070	790
33,4	1,315	1,80	C-90	EUE	1 130	830
33,4	1,315	1,72	H-40	IJ	410	310
33,4	1,315	1,72	J-55	IJ	540	400
33,4	1,315	1,72	C-75	IJ	700	520
33,4	1,315	1,72	L-80	IJ	720	530
33,4	1,315	1,72	N-80	IJ	740	550
33,4	1,315	1,72	C-90	IJ	780	580
42,2	1,660	2,30	H-40	NU	360	270
42,2	1,660	2,30	J-55	NU	470	350
42,2	1,660	2,30	C-75	NU	620	460
42,2	1,660	2,30	L-80	NU	640	470
42,2	1,660	2,30	N-80	NU	660	490
42,2	1,660	2,30	C-90	NU	700	510

Table 3 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
42,2	1,660	2,30	H-40	EUE	720	530
42,2	1,660	2,40	J-55	EUE	940	690
42,2	1,660	2,40	C-75	EUE	1 230	910
42,2	1,660	2,40	L-80	EUE	1 270	940
42,2	1,660	2,40	N-80	EUE	1 300	960
42,2	1,660	2,40	C-90	EUE	1 380	1 020
42,2	1,660	2,10	H-40	IJ	520	380
42,2	1,660	2,33	H-40	IJ	520	380
42,2	1,660	2,10	J-55	IJ	680	500
42,2	1,660	2,33	J-55	IJ	680	500
42,2	1,660	2,33	C-75	IJ	890	650
42,2	1,660	2,33	L-80	IJ	920	680
42,2	1,660	2,33	N-80	IJ	940	690
42,2	1,660	2,33	C-90	IJ	1 000	730
48,3	1,900	2,75	H-40	NU	430	320
48,3	1,900	2,75	J-55	NU	560	410
48,3	1,900	2,75	C-75	NU	730	540
48,3	1,900	2,75	L-80	NU	760	560
48,3	1,900	2,75	N-80	NU	780	570
48,3	1,900	2,75	C-90	NU	830	610
48,3	1,900	2,90	H-40	EUE	910	670
48,3	1,900	2,90	J-55	EUE	1 190	880
48,3	1,900	2,90	C-75	EUE	1 560	1 150
48,3	1,900	2,90	L-80	EUE	1 610	1 190
48,3	1,900	2,90	N-80	EUE	1 650	1 220
48,3	1,900	2,90	C-90	EUE	1 760	1 300
48,3	1,900	2,40	H-40	IJ	600	450
48,3	1,900	2,76	H-40	IJ	600	450
48,3	1,900	2,40	J-55	IJ	790	580
48,3	1,900	2,76	J-55	IJ	790	580
48,3	1,900	2,76	C-75	IJ	1 030	760
48,3	1,900	2,76	L-80	IJ	1 070	790
48,3	1,900	2,76	N-80	IJ	1 100	810
48,3	1,900	2,76	C-90	IJ	1 160	860

Table 3 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
52,4	2,063	3,25	H-40	IJ	770	570
52,4	2,063	3,25	J-55	IJ	1 010	740
52,4	2,063	3,25	C-75	IJ	1 320	970
52,4	2,063	3,25	L-80	IJ	1 370	1 010
52,4	2,063	3,25	N-80	IJ	1 400	1 030
52,4	2,063	3,25	C-90	IJ	1 490	1 100
60,3	2,375	4,00	H-40	NU	630	470
60,3	2,375	4,60	H-40	NU	760	560
60,3	2,375	4,00	J-55	NU	830	610
60,3	2,375	4,60	J-55	NU	990	730
60,3	2,375	4,00	C-75	NU	1 090	800
60,3	2,375	4,60	C-75	NU	1 300	960
60,3	2,375	5,80	C-75	NU	1 860	1 380
60,3	2,375	4,00	L-80	NU	1 130	830
60,3	2,375	4,60	L-80	NU	1 350	990
60,3	2,375	5,80	L-80	NU	1 930	1 420
60,3	2,375	4,00	N-80	NU	1 160	850
60,3	2,375	4,60	N-80	NU	1 380	1 020
60,3	2,375	5,80	N-80	NU	1 980	1 460
60,3	2,375	4,00	C-90	NU	1 230	910
60,3	2,375	4,60	C-90	NU	1 470	1 080
60,3	2,375	5,80	C-90	NU	2 110	1 550
60,3	2,375	4,60	P-105	NU	1 740	1 280
60,3	2,375	5,80	P-105	NU	2 490	1 840
60,3	2,375	4,70	H-40	EUE	1 340	990
60,3	2,375	4,70	J-55	EUE	1 750	1 290
60,3	2,375	4,70	C-75	EUE	2 310	1 700
60,3	2,375	5,95	C-75	EUE	2 870	2 120
60,3	2,375	4,70	L-80	EUE	2 390	1 760
60,3	2,375	5,95	L-80	EUE	2 970	2 190
60,3	2,375	4,70	N-80	EUE	2 450	1 800
60,3	2,375	5,95	N-80	EUE	3 040	2 240
60,3	2,375	4,70	C-90	EUE	2 610	1 920
60,3	2,375	5,95	C-90	EUE	3 250	2 390
60,3	2,375	4,70	P-105	EUE	3 080	2 270
60,3	2,375	5,95	P-105	EUE	3 830	2 830
73,0	2,875	6,40	H-40	NU	1 080	900
73,0	2,875	6,40	J-55	NU	1 420	1 050

Table 3 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
73,0	2,875	6,40	C-75	NU	1 880	1 380
73,0	2,875	7,80	C-75	NU	2 500	1 850
73,0	2,875	8,60	C-75	NU	2 830	2 090
73,0	2,875	6,40	L-80	NU	1 940	1 430
73,0	2,875	7,80	L-80	NU	2 590	1 910
73,0	2,875	8,60	L-80	NU	2 930	2 160
73,0	2,875	6,40	N-80	NU	1 990	1 470
73,0	2,875	7,80	N-80	NU	2 650	1 960
73,0	2,875	8,60	N-80	NU	3 000	2 210
73,0	2,875	6,40	C-90	NU	2 130	1 570
73,0	2,875	7,80	C-90	NU	2 840	2 090
73,0	2,875	8,60	C-90	NU	3 210	2 370
73,0	2,875	6,40	P-105	NU	2 510	1 850
73,0	2,875	7,80	P-105	NU	3 350	2 470
73,0	2,875	8,60	P-105	NU	3 790	2 790
73,0	2,875	6,50	H-40	EUE	1 700	1 250
73,0	2,875	6,50	J-55	EUE	2 230	1 650
73,0	2,875	6,50	C-75	EUE	2 940	2 170
73,0	2,875	7,90	C-75	EUE	3 540	2 610
73,0	2,875	8,70	C-75	EUE	3 860	2 850
73,0	2,875	6,50	L-80	EUE	3 050	2 250
73,0	2,875	7,90	L-80	EUE	3 680	2 710
73,0	2,875	8,70	L-80	EUE	4 000	2 950
73,0	2,875	6,50	N-80	EUE	3 120	2 300
73,0	2,875	7,90	N-80	EUE	3 760	2 770
73,0	2,875	8,70	N-80	EUE	4 090	3 020
73,0	2,875	6,50	C-90	EUE	3 340	2 460
73,0	2,875	7,90	C-90	EUE	4 020	2 970
73,0	2,875	8,70	C-90	EUE	4 380	3 230
73,0	2,875	6,50	P-105	EUE	3 940	2 910
73,0	2,875	7,90	P-105	EUE	4 750	3 500
73,0	2,875	8,70	P-105	EUE	5 170	3 810
88,9	3,500	7,70	H-40	NU	1 250	920
88,9	3,500	9,20	H-40	NU	1 520	1 120
88,9	3,500	10,20	H-40	NU	1 770	1 310
88,9	3,500	7,70	J-55	NU	1 640	1 210
88,9	3,500	9,20	J-55	NU	2 010	1 480
88,9	3,500	10,20	J-55	NU	2 330	1 720
88,9	3,500	7,70	C-75	NU	2 170	1 600

Table 3 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
88,9	3,500	9,20	C-75	NU	2 650	1 950
88,9	3,500	10,20	C-75	NU	3 080	2 270
88,9	3,500	12,70	C-75	NU	4 100	3 030
88,9	3,500	7,70	L-80	NU	2 250	1 660
88,9	3,500	9,20	L-80	NU	2 750	2 030
88,9	3,500	10,20	L-80	NU	3 200	2 360
88,9	3,500	12,70	L-80	NU	4 260	3 140
88,9	3,599	7,70	N-80	NU	2 300	1 700
88,9	3,500	9,20	N-80	NU	2 810	2 070
88,9	3,500	10,20	N-80	NU	3 270	2 410
88,9	3,500	12,70	N-80	NU	4 350	3 210
88,9	3,500	7,70	C-90	NU	2 460	1 820
88,9	3,500	9,20	C-90	NU	3 010	2 220
88,9	3,500	10,20	C-90	NU	3 510	2 590
88,9	3,500	12,70	C-90	NU	4 670	3 440
88,9	3,500	9,20	P-105	NU	3 550	2 620
88,9	3,500	12,70	P-105	NU	5 510	4 060
88,9	3,500	9,30	H-40	EUE	2 340	1 730
88,9	3,500	9,30	J-55	EUE	3 090	2 280
88,9	3,500	9,30	C-75	EUE	4 080	3 010
88,9	3,500	12,95	C-75	EUE	5 480	4 040
88,9	3,500	9,30	L-80	EUE	4 240	3 030
88,9	3,500	12,95	L-80	EUE	5 700	4 200
88,9	3.500	9,30	N-80	EUE	4 330	3 200
88,9	3,500	12,95	N-80	EUE	5 820	4 290
88,9	3,500	9,30	C-90	EUE	4 650	3 430
88,9	3,500	12,95	C-90	EUE	6 250	4 610
88,9	3,500	9,30	P-105	EUE	5 490	4 050
88,9	3,500	12,95	P-105	EUE	7 370	5 430
101,6	4,000	9,50	H-40	NU	1 260	930
101,6	4,000	9,50	J-55	NU	1 660	1 220
101,6	4,000	9,50	C-75	NU	2 200	1 620
101,6	4,000	9,50	L-80	NU	2 280	1 680
101,6	4,000	9,50	N-80	NU	2 330	1 720
101,6	4,000	9,50	C-90	NU	2 500	1 950
101,6	4,000	11,00	H-40	EUE	2 630	1 940
101,6	4,000	11,00	J-55	EUE	3 470	2 560
101,6	4,000	11,00	C-75	EUE	4 600	3 390
101,6	4,000	11,00	L-80	EUE	4 780	3 530

Table 3 *(continued)*

Size (outside diameter)		Nominal mass (threads and coupling)	Grade	Thread	Torque	
mm	in	lb/ft			N·m	ft·lbf
101,6	4,000	11,00	N-80	EUE	4 880	3 600
101,6	4,000	11,00	C-90	EUE	5 250	3 870
114,3	4,500	12,60	H-40	NU	1 780	1 320
114,3	4,500	12,60	J-55	NU	2 360	1 740
114,3	4,500	12,60	C-75	NU	3 120	2 300
114,3	4,500	12,60	L-80	NU	3 250	2 400
114,3	4,500	12,60	N-80	NU	3 310	2 440
114,3	4,500	12,60	C-90	NU	3 570	2 630
114,3	4,500	12,75	H-40	EUE	2 930	2 160
114,3	4,500	12,75	J-55	EUE	3 870	2 860
114,3	4,500	12,75	C-75	EUE	5 130	3 780
114,3	4,500	12,75	L-80	EUE	5 340	3 940
114,3	4,500	12,75	N-80	EUE	5 450	4 020
114,3	4,500	12,75	C-90	EUE	5 870	4 330

NOTE 1 It is recommended that the makeup target be based on position, not torque (see 5.2.4 and 5.3.1).

NOTE 2 Under normal circumstances, variations in the listed torque values of ± 25 % should be considered acceptable.

Table 4 — Colour code identification

Conditions	Colour
Damaged coupling or box connections	One red paint band approximately 50 mm (2 in) wide around the affected coupling or box end.
Damaged field- or pin-end threads	One red paint band approximately 50 mm (2 in) wide around the pipe adjacent to affected threads.
Pipe body will not pass drift test	One green band approximately 50 mm (2 in) wide at the point of drift restriction and adjacent to the colour band denoting body wall classification.

Table 5 — Classification and colour coding of used casing and tubing

Class	Colour band	Loss of nominal wall thickness %	Remaining wall thickness % min.
2	Yellow	0 to 15	85
3	Blue	16 to 30	70
4	Green	31 to 50	50
5	Red	over 50	less than 50

Annex A
(informative)

SI units

Metric units have been obtained by converting customary U.S. units in accordance with ISO 31-3.

Table A.1 — SI units

Quantity	Customary U.S. unit	SI unit
Area	1 square inch (in^2)	645,16 square millimetres (mm^2) (exactly)
Flow rate	1 barrel per day (bbl/d)	0,158 987 cubic metres per day (m^3/d)
	1 cubic foot per minute (ft^3/min)	0,028 316 85 cubic metres per minute (m^3/min) or 40,776 192 cubic metres per day (m^3/d)
Force	1 pound-force (lbf)	4,448 222 newtons (N)
Impact energy	1 foot pound-force (ft·lbf)	1,355 818 Joules (J)
Length	1 inch (in)	25,4 millimetres (mm) (exactly)
	1 foot (ft)	304,8 millimetres (mm) (exactly)
Mass	1 pound (lb)	0,453 592 37 kilograms (kg) (exactly)
Pressure	1 pound-force per square inch (lbf/in^2) or 1 pound per square inch (psi) NOTE 1 bar = 10^5 Pa	6 894,757 pascals (Pa)
Strength or stress	1 pound-force per square inch (lbf/in^2)	6 894,757 pascals (Pa)
Temperature	The formula given opposite was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C)	$°C = \frac{5}{9}(°F - 32)$
Torque	1 inch pound-force (in·lbf)	0,112 985 newton metres (N·m)
	1 foot pound-force (ft·lbf)	1,355 818 newton metres (N·m)
Velocity	1 foot per second (ft/s)	0,304 8 metres per second (m/s) (exactly)
Volume	1 cubic inch (in^3)	$16,387\,064 \times 10^{-3}$ cubic centimetres (cm^3) (exactly)
	1 cubic foot (ft^3)	0,028 316 8 cubic metres (m^3) or 28,316 8 cubic centimetres (cm^3)
	1 gallon (U.S.)	0,003 785 4 cubic metres (m^3) or 3,785 4 cubic decimetres (dm^3)
	1 barrel (U.S.)	0,158 987 cubic metres (m^3) or 158,987 cubic decimetres (dm^3)

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