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
ISO 10405:2000(E)

Contents

Page

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*.

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.