INTERNATIONAL STANDARD

ISO 14693

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Petroleum and natural gas industries — Drilling and well-servicing equipment

Industries du pétrole et du gaz naturel — Équipement de forage et d'entretien des puits

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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14693 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

Introduction

International Standard ISO 14693 is based upon API Specification 7K (3rd edition).

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

Petroleum and natural gas industries — Drilling and well-servicing equipment

1 Scope

This International Standard provides general principles and specifies requirements for design, manufacture and testing of new drilling and well-servicing equipment and of replacement primary load-carrying components manufactured subsequent to the publication of this International Standard.

This International Standard is applicable to the following equipment:

a) rotary tables;

b) rotary bushings;

c) rotary slips;

d) rotary hoses;

e) piston mud-pump components;

f) drawworks components;

g) spiders not capable of use as elevators;

h) manual tongs;

i) safety clamps not used as hoisting devices;

j) power tongs, including spinning wrenches.

Annex A gives a number of standardized supplementary requirements which apply only when specified.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148, *Steel — Charpy impact test (V-notch)*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

API Spec 5B, *Specification for threading, gaging and thread inspection of casing, tubing, and line pipe threads*

ANSI/AGMA[1] 2004-B89, *Gear Materials and Heat Treatment Manual*

ANSI[2]/ASME[3] B1.1, *Unified Inch Screw Threads (UN and UNR Thread Form)*

ANSI/ASME B1.2, *Gages and Gaging for Unified Inch Screw Threads*

ANSI/AWS[4] D1.1, *Structural Welding Code — Steel*

ASME Boiler and Pressure Vessel Code Section V, *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code Section VIII, *Alternative Rules for Construction of High Pressure Vessels*

ASME Boiler and Pressure Vessel Code Section IX, *Welding and Brazing Qualifications*

ASNT[5] TC-1A, *Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing*

ASTM[6] A 370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A 388, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings*

ASTM A 751, *Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products*

ASTM A 770, *Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications*

ASTM E 4, *Standard Practices for Force Verification of Testing Machines*

ASTM E 125, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings*

ASTM E 165, *Standard Test Method for Liquid Penetrant Examination*

ANSI/ASTM E 186, *Standard Reference Radiographs for Heavy-Walled (2 to 4 1/2-in. (51 to 114-mm)) Steel Castings*

ANSI/ASTM E 280, *Standard Reference Radiographs for Heavy-Walled (4 1/2 to 12-in. (114 to 305-mm)) Steel Castings*

ASTM E 428, *Standard Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Examination*

ANSI/ASTM E 446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (51 mm) in Thickness*

ASTM E 709, *Standard Guide for Magnetic Particle Examination*

AWS QC1, *Certification of Welding Inspectors*

EN 287 (all parts), *Approval testing of welders — Fusion welding*

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1) American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, VA 22314, USA.

2) American National Standards Institute, 1430 Broadway, New York, NY 10018, USA

3) American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017, USA.

4) American Welding Society, 550 N.W. LeJeune Road, Box 351040, Miami, FL 33135, USA.

5) American Society for Nondestructive Testing, 4153 Arlingate Plaza, Box 28518, Columbus, OH 43228, USA.

6) American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428, USA.

MSS[7] SP-53, *Quality Standard for Steel Castings and Forgings for Valves, Flanges and Fittings and other Piping Components — Magnetic Particle Examination Method*

MSS SP-55, *Quality Standard for Steel Castings for Valves, Flanges and Fittings and other Piping Components- Visual Method for Evaluation of Surface Irregularities*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms, definitions and abbreviated terms apply.

3.1 Terms and definitions

3.1.1
critical area
highly stressed regions on a primary load-carrying component

3.1.2
design load
sum of the static and dynamic loads that would induce the maximum allowable stress in the equipment

3.1.3
design safety factor
factor to account for a certain safety margin between the maximum allowable stress and the minimum specified yield strength of the material

3.1.4
design verification test
test undertaken to validate the integrity of the design calculations used

3.1.5
dynamic load
load applied to the equipment due to acceleration effects

3.1.6
equivalent round
ER
standard for comparing variously shaped sections to round bars, used in determining the response to hardening characteristics when heat-treating low-alloy and martensitic corrosion-resistant steels

3.1.7
identical design concept
property of a family of units whereby all units of the family have similar geometry in the primary load-carrying areas

3.1.8
linear indication
indication, revealed by non-destructive examination, having a length at least three times its width

3.1.9
maximum allowable stress
specified minimum yield strength divided by the design safety factor

7) Manufacturers Standardization Society of the Valve and Fittings Industry; 127 Park Street NE; Vienna, VA 22180; USA.

3.1.10
primary load
load that arises within the equipment when the equipment is performing its primary design function

3.1.11
primary load-carrying component
component of the equipment through which the primary load is carried

3.1.12
proof load test
production load test undertaken to validate the structural soundness of the equipment

3.1.13
rated load
maximum operating load, both static and dynamic, to be applied to the equipment

NOTE The rated load is numerically equivalent to the design load.

3.1.14
rated speed
rate of rotation, motion or velocity as specified by the manufacturer

3.1.15
repair
removal of defects from, and refurbishment of, a component or assembly by welding during the manufacturing process

NOTE The term "repair", as referred to in this International Standard, applies only to the repair of defects in materials during the manufacture of new equipment.

3.1.16
rounded indication
indication, revealed by nondestructive examination, with a circular or elliptical shape and having a length less than three times its width

3.1.17
safe working load
design load reduced by the dynamic load

3.1.18
size class
designation of the dimensional interchangeability of equipment specified herein

3.1.19
size range
range of tubular diameters to which an assembly is applicable

3.1.20
special process
operation that may change or affect the mechanical properties, including toughness, of the materials used in the equipment

3.1.21
test unit
prototype unit upon which a design verification test is conducted

3.2 Abbreviated terms

HAZ heat-affected zone

NDE non-destructive examination

PWHT post-weld heat treatment

TIR total indicated runout

4 Design

4.1 Design conditions

Drilling equipment shall be designed, manufactured and tested such that it is in every respect fit for its intended purpose. The equipment shall safely transfer the load for which it is intended. The equipment shall be designed for safe operation.

The following design conditions shall apply:

— the design load and the safe working load are defined as in Clause 3. The operator of the equipment shall be responsible for the determination of the safe working load for specific operations;

— unless changed by a supplementary requirement (see Annex A, SR2 and SR2A), the design and minimum operating temperature for rotary tables, rotary slips, power tongs and drawworks is 0 °C (32 °F). The design and minimum operating temperature for safety clamps, spiders and manual tongs is –20 °C (–4 °F), unless changed by a supplementary requirement.

CAUTION — Use of equipment covered by this International Standard at rated loads and temperatures below the design temperatures noted above is not recommended unless appropriate materials with the required toughness properties at lower design temperatures have been used in the manufacture of the equipment (see Annex A, SR2 and SR2A).

4.2 Strength analysis

4.2.1 General

The equipment design analysis shall address excessive yielding, fatigue or buckling as possible modes of failure.

The strength analysis shall be based on the elastic theory. Alternatively, ultimate strength (plastic) analysis may be used where justified by design documentation.

All forces that may govern the design shall be taken into account. For each cross-section to be considered, the most unfavorable combination, position, and direction of forces shall be used.

4.2.2 Simplified assumptions

Simplified assumptions regarding stress distribution and stress concentration may be used, provided that assumptions are made in accordance with generally accepted practice or based on sufficiently comprehensive experience or tests.

4.2.3 Empirical relationships

Empirical relationships may be used in lieu of analysis, provided such relationships are supported by documented strain gauge test results that verify the stresses within the component. Equipment or components which, by their design, do not permit the attachment of strain gauges to verify the design shall be qualified by testing in accordance with 5.6.

4.2.4 Equivalent stress

The strength analysis shall be based on elastic theory. The nominal equivalent stress, according to the Von Mises-Hencky theory, caused by the design load shall not exceed the maximum allowable stress σ_{allow} as calculated by Equation (1).

$$\sigma_{\text{allow}} = \frac{S_{\text{Ymin}}}{F_{\text{DS}}} \qquad (1)$$

where

S_{Ymin} is the specified minimum yield strength;

F_{DS} is the design safety factor.

4.2.5 Ultimate strength (plastic) analysis

An ultimate strength (plastic) analysis may be performed under any one of the following conditions:

a) for contact areas;

b) for areas of highly localized stress concentrations caused by part geometry, and other areas of high stress gradients where the average stress in the section is less than or equal to the maximum allowable stress as defined in 4.2.4.

In such areas, the elastic analysis shall govern for all values of stress below the average stress.

In the case of plastic analysis, the nominal equivalent stress according to the Von Mises-Hencky theory shall not exceed the maximum allowable stress σ_{allow} as calculated by Equation (2).

$$\sigma_{\text{allow}} = \frac{S_{\text{ULTmin}}}{F_{\text{DS}}} \qquad (2)$$

where

S_{ULTmin} is the specified minimum ultimate tensile strength;

F_{DS} is the design safety factor.

4.2.6 Stability analysis

The stability analysis shall be carried out according to generally accepted theories of buckling.

4.2.7 Fatigue analysis

The fatigue analysis shall be based on a time period of not less than 20 years, unless otherwise agreed.

The fatigue analysis shall be carried out according to generally accepted theories. A method that may be used is defined in reference [3].

4.3 Size class designation

The size class designation for equipment shall represent dimensional interchangeability in accordance with Clause 9.

4.4 Rating

4.4.1 Rotary tables, spiders, manual and power tongs furnished under this International Standard shall be rated in accordance with the requirements specified herein.

4.4.2 The static ratings for all bearings within the primary load path shall meet or exceed the rated load for the equipment.

4.4.3 Power and manual tongs shall be assigned torque ratings by the manufacturer for all configurations for which the tong is designed.

4.5 Load rating basis

The load rating shall be based on:

a) the design safety factor as specified in 4.6;

b) the minimum specified yield strength of the material used in the primary load-carrying components;

c) the stress distribution as determined by design calculations and/or data developed in a design verification load test as specified in 5.6.

4.6 Design safety factor

4.6.1 Design safety factor for spiders shall be established as follows:

Load rating R	**Design safety factor** F_{DS}
$<$ 1 334 kN (150 short tons)	3,00
1 334 kN to 4 448 kN (150 short tons to 500 short tons) inclusive	$3,00 - 0,75(R - 1\ 334)/3\ 114$[a] $3,00 - 0,75(R - 150)/350$[b]
$>$ 4 448 kN (500 short tons)	2,25

[a] In this formula, the value of R shall be expressed in SI units of kilonewtons.

[b] In this formula, the value of R shall be expressed in USC units of short tons.

The design safety factor is intended as a design criterion and shall not under any circumstances be construed as allowing loads on the equipment in excess of the rated load.

4.6.2 The minimum design safety factor of structural components in the primary load path of rotary tables shall be 1,67.

4.6.3 The minimum design safety factor for manual tongs, jaws, and snub-line attachments of power tongs shall be established as follows:

Torque rating R	**Design safety factor** F_{DS}
$\leqslant$ 41 kN·m (30 × 10³ ft-lb)	3,00
> 41 kN·m (30 × 10³ ft-lb) to 136 kN·m (100 × 10³ ft-lb)	$3{,}00 - 0{,}75\ (R - 41)/95$ [a] $3{,}00 - 0{,}75(R - 30 \times 10^3)/(70 \times 10^3)$ [b]
$\geqslant$ 136 kN·m (100 × 10³ ft-lb)	2,25

[a] In this formula, the value of R shall be expressed in SI units of kilonewton metres.

[b] In this formula, the value of R shall be expressed in USC units of foot-pounds.

4.7 Shear strength

For purposes of design calculations involving shear, the ratio of yield strength in shear to yield strength in tension shall be 0,58.

4.8 Specific equipment

See Clause 9 for equipment-specific design requirements.

4.9 Design documentation

Documentation of design shall include methods, assumptions, calculations, and design requirements. Design requirements shall include but not be limited to those criteria for size, test and operating pressures, material, environmental and specification requirements, and other pertinent requirements upon which the design is to be based.

The requirements also apply to design change documentation.

5 Design verification

5.1 General

To ensure the integrity of the design and supporting calculations, equipment shall be subject to design verification testing when required in Clause 9.

Design verification testing shall be performed in accordance with documented procedures.

Design verification testing shall be carried out or certified by personnel who are independent of those having direct responsibility for the design and manufacture of the product and are qualified to perform their task.

Design verification testing may consist of one or more of the listed tests as required by the specific equipment clauses of this International Standard:

a) function testing;

b) pressure testing;

c) load testing.

5.2 Design verification function test

5.2.1 Sampling of test units

One unit of each model of equipment shall be subjected to function testing if the equipment transmits force, motion or energy by means of continued movement of the equipment parts.

5.2.2 Test procedure

The manufacturer shall establish a procedure documenting the duration, applied load and speed of the test. For equipment designed for continuous operation, the test unit shall be operated at rated speed for a minimum of 2 h. For equipment designed for intermittent or cyclical operation, the test unit shall be operated at rated speed and established duty cycles equivalent to 2 h operation or ten duty cycles, whichever is greater, unless otherwise specified by Clause 9.

5.2.3 Qualification

The unit shall operate without noted loss of power. The temperature of the bearings and lubrication oil shall be within acceptable limits as established by the design and documented in the test procedure.

5.3 Design verification pressure test

5.3.1 Sampling of test units

Each design of pressure-containing items or, as defined in Clause 9, primary load-carrying components, where the primary load is pressure, shall be hydrostatically tested for design verification. Hydraulic power transmission components are excluded from this test.

5.3.2 Test procedure

The test pressure shall be 1,5 times the maximum rated operating pressure. Cold water, water with additives, or the fluid normally used in actual service shall be used as the test fluid. Tests shall be performed on the completed part or assembly before painting.

The hydrostatic test shall be applied for two cycles. Each cycle shall consist of the following four steps:

a) the primary pressure-holding period;

b) the reduction of the test pressure to zero;

c) thorough drying of all external surfaces of the item being tested;

d) the secondary pressure-holding period.

The pressure-holding periods shall not start until the test pressure has been reached, and the equipment and pressure-monitoring gauge isolated from the pressure source. The pressure-holding periods shall not be less than 3 min.

5.3.3 Qualification

After each test cycle, the test item shall be carefully inspected for the absence of leakage or permanent deformation. Failure to meet this requirement, or premature failure, shall be the cause for a complete reassessment of the design, followed by repetition of the test.

5.3.4 Individual parts

Individual parts of the unit may be tested separately if the test fixture duplicates the loading conditions applicable to the part in the assembled unit.

5.4 Design verification load test

5.4.1 Design verification load test

When required by the specific equipment paragraphs of Clause 9, equipment shall be subjected to a design verification load test.

5.4.2 Sampling of test units

To qualify design stress calculations applied to a family of units with an identical design concept but of varying sizes and ratings, one of the following options shall apply:

a) a minimum of three units of the design shall be subjected to design verification load testing. The test units shall be selected from the lower end, middle, and upper end of the load rating range;

b) alternatively, the required number of test units can be established on the basis that each test unit also qualifies one load rating above and one below that of the selected test unit. (This option would generally apply to limited product rating ranges.)

5.4.3 Test procedure

The test procedure is as follows.

a) An assembled test unit shall be loaded to the maximum rated load. After this load has been released, the unit shall be checked for its intended design functions. The function of all of the equipment parts shall not be impaired by this loading.

b) Strain gauges shall be applied to the test unit at all places where high stresses are anticipated, provided that the configuration of the unit permits such techniques. The use of finite-element analysis, models, brittle lacquer, and so forth, is recommended to confirm the proper location of the strain gauges. Three-element strain gauges are recommended in critical areas to permit determination of the shear stresses and to eliminate the need for exact orientation of the gauges.

c) The design verification test load to be applied to the test unit shall be determined as follows:

$$\text{Design verification test load} = 0{,}8 \times R \times F_{\mathrm{DS}}, \text{ but not less than } 2R \quad (3)$$

where

R is the load rating in kilonewtons (short tons) or kilonewton metres (foot-pounds), as applicable;

F_{DS} is the design safety factor as defined in 3.1.3 and 4.6.

d) The test unit shall be loaded to the design verification test load. This test load should be applied incrementally, reading the strain gauge values and observing for evidence of yielding. The test unit may be loaded as many times as necessary to obtain adequate data.

e) The stress values computed from the strain gauge readings shall not exceed the values obtained from design calculations (based on the design verification test load) by more than the uncertainty of the testing apparatus specified in 5.7. Failure to meet this requirement, or premature failure of any test unit, shall be a cause for complete reassessment of the design, followed by additional testing of an identical number of test units as originally required, including a test unit of the same load rating as the one that failed.

f) Upon completion of the design verification load test, the test unit shall be disassembled and the dimensions of each primary load-carrying component checked for evidence of permanent deformation.

g) Individual parts of a test unit may be load-tested separately if the holding fixtures duplicate the loading conditions applicable to the part in the assembled unit.

5.5 Determination of rated load

The rated load shall be determined from the results of the design verification load test and/or stress distribution calculations required by Clause 4. The stresses at that rating shall not exceed the maximum allowable stress. Localized yielding shall be permitted at areas of contact. In a unit that has been design verification load-tested, the critical permanent deformation determined by strain gauges or other suitable means shall not exceed 0,2 % except in contact areas. If the stresses exceed the allowable values, the affected part or parts shall be redesigned to obtain the desired rating. Stress distribution calculations may be used to load-rate the equipment only if the stress values determined in the analysis are no less than the stresses observed during the design verification load test.

5.6 Alternative design verification test procedure and rating

Destructive testing of the test unit may be used, provided the yield and tensile strengths of the material used in the equipment have been determined. This may be accomplished using tensile test specimens from the same heat and heat treatment lot as the parts represented, and meeting the requirements of ISO 6892 or ASTM A 370.

Each component of an assembly shall be qualified under the most unfavorable loading configuration. Components may be qualified using either of the following methods.

a) The ratio T_{R} shall be computed for each component in the assembly. The smallest of these ratios shall be used in the equations.

b) Each component may be load-tested separately if the holding fixtures duplicate the loading conditions applicable. In this case, the ratio, T_{R}, used for each test shall be that computed for the specific component tested.

$$R = L_{\mathrm{b}} \times \frac{T_{\mathrm{R}}}{F_{\mathrm{DS}}} \quad (4)$$

$$T_{\mathrm{R}} = \frac{S_{\mathrm{Ymin}}}{S_{\mathrm{ULTa}}} \quad (5)$$

where

L_{b} is the breaking load;

S_{Ymin} is the specified minimum yield strength;

S_{ULTa} is the actual tensile strength;

F_{DS} is the design safety factor (4.6);

R is the load rating.

Since this method of design qualification is not derived from stress calculations, qualification shall be limited to the specific model, size, size range, and rating tested.

5.7 Design verification load-testing apparatus

The loading apparatus used to duplicate the working load on the test unit shall be calibrated in accordance with ISO 7500-1 or ASTM E 4 so as to ensure that the prescribed test load is obtained. For loads exceeding 3 560 kN (400 tons), the load-testing apparatus may be verified with calibration devices traceable to a Class A calibration device and having an uncertainty of less than 2,5 %.

Test fixtures shall load the unit (or part) in the same manner as in actual service, and with the same areas of contact on the load-bearing surface. All equipment used to load the unit (or part) shall be verified as to its capability to perform the test.

5.8 Design changes

When any change in design or manufacture is made that changes the calculated load rating, supportive design verification testing in conformance with this clause shall be carried out. The manufacturer shall evaluate all changes in design or manufacture to determine whether the calculated load ratings are affected. This evaluation shall be documented.

5.9 Records

All design verification records and supporting data shall be subject to the same controls as specified for design documentation in Clause 11.

6 Materials requirements

6.1 General

This clause describes the various material qualification, property, and processing requirements for primary load-carrying and pressure-containing components unless otherwise specified.

6.2 Written specifications

Materials used in the manufacture of primary load-carrying components of equipment to which this International Standard is applicable shall conform to a written specification that meets or exceeds the design requirements.

6.3 Mechanical properties

6.3.1 Impact toughness

Impact testing shall be in accordance with ISO 148 (Charpy) or ASTM A 370.

When it is necessary for subsize impact test pieces to be used, the acceptance criteria shall be multiplied by the appropriate adjustment factor listed in Table 1. Subsize test pieces of width less than 5 mm are not permitted.

For design temperatures below those specified in 4.1, supplementary impact toughness requirements may apply. See Annex A, Supplementary Requirements SR2 and SR2A.

Table 1 — Adjustment factors for subsize impact specimens

Specimen dimensions mm × mm	Adjustment factor
10,0 × 7,5	0,833
10,0 × 5,0	0,667

6.3.2 Through-thickness properties

Where the design requires through-thickness properties, materials shall be tested for reduction of area in the through-thickness direction in accordance with ASTM A 770. The minimum reduction shall be 25 %.

6.4 Material qualification

The mechanical tests required by this International Standard shall be performed on qualification test coupons representing the heat and heat treatment lot used in the manufacture of the component. Tests shall be performed in accordance with the requirements of ISO 6892, ISO 148 or ASTM A 370, or equivalent national standards, using material in the final heat-treated condition. For the purposes of material qualification testing, stress relief following welding is not considered heat treatment, provided that the PWHT temperature is below that which changes the heat-treated condition of the base material. Material qualification tests may be performed before the stress-relieving process, provided that the stress-relieving temperature is below that which changes the heat-treatment condition.

Determine the size of the qualification test coupon for a part using the equivalent-round method. Figure 1 and Figure 2 illustrate the basic models for determining the equivalent round of simple solid and hollow parts. Any of the shapes shown may be used for the qualification test coupon. Figure 4 describes the steps for determining the governing equivalent-round for more complex sections. Determine the equivalent round of a part using the actual dimensions of the part in the “as-heat-treated” condition. The equivalent round of the qualification test coupon shall be equal to or greater than the equivalent-round dimensions of the part it qualifies, except that the equivalent round is not required to exceed 125 mm (5 in). Figure 3 and Figure 5 illustrate the procedure for determining the required dimensions of an ASTM A 370 keel block.

Qualification test coupons shall either be integral with the components they represent, or be separate from the components, or be taken from sacrificed production part(s). In all cases, test coupons shall be from the same heat as the components they qualify, shall be subjected to the same working operations and shall be heat-treated together with the components.

Test specimens shall be removed from integral or separate qualification test coupons so that their longitudinal centreline axis is entirely within the centre core 1/4-thickness envelope for a solid test coupon, or within 3 mm (1/8 in) of the mid-thickness of the thickest section of a hollow test coupon. The gauge length of a tensile specimen or the notch of an impact specimen shall be at least 1/4-thickness from the ends of the test coupon.

Test specimens taken from sacrificed production parts shall be removed from the centre core 1/4-thickness envelope location of the thickest section of the part.

6.5 Manufacture

The manufacturing processes shall ensure repeatability in producing components that meet all the requirements of this International Standard.

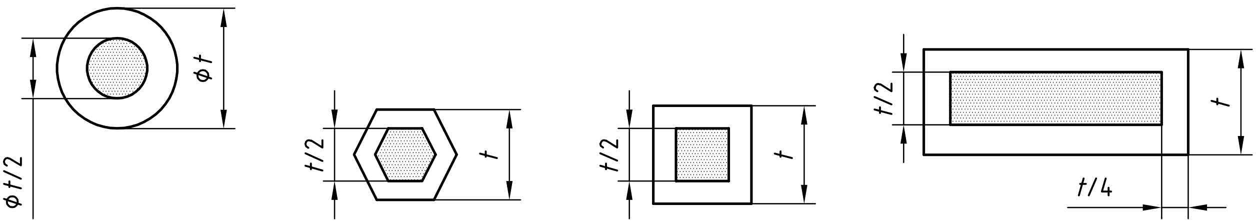
All wrought materials shall be manufactured using processes that produce a wrought structure throughout the component.

All heat-treatment operations shall be performed utilizing equipment qualified in accordance with the requirements specified by the manufacturer or processor. The loading of the material within heat-treatment furnaces shall be such that the presence of any one part does not adversely affect the heat-treating response of any other part within the heat-treatment lot. The temperature and time requirements for heat-treatment cycles shall be determined in accordance with the manufacturer's or processor's written specification. Actual heat-treatment temperatures and times shall be recorded, and heat-treatment records shall be traceable to relevant components.

NOTE Annex B provides recommendations for qualification of heat-treating equipment.

6.6 Chemical composition

The material composition of each heat shall be analysed in accordance with the requirements of ASTM A 751 (see for further information ISO/TR 9769), or equivalent national standard, for all elements specified in the manufacturer's written material specification.



ER = t **a) Round**

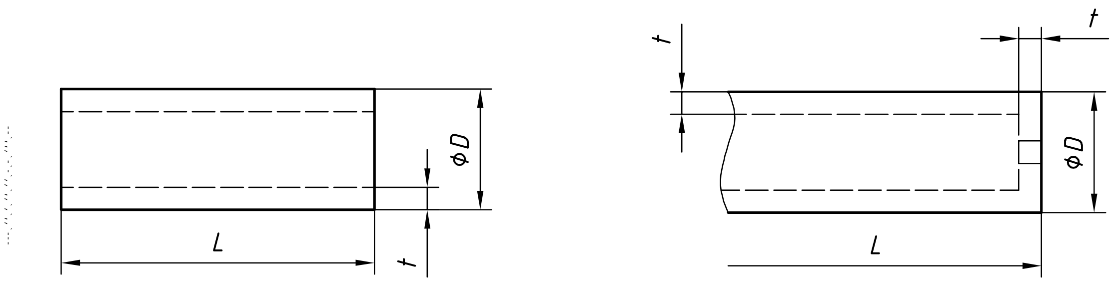
ER = 1,1t **b) Hexagon**

ER = 1,25t **c) Square**

ER = 1,5t **d) Rectangle or plate**

NOTE When L is $< t$, consider section as a plate of thickness L.

Figure 1 — Equivalent round models — Solids of length L



a) Open both ends[a]

ER = 2t

b) Restricted or closed at one or both ends[b]

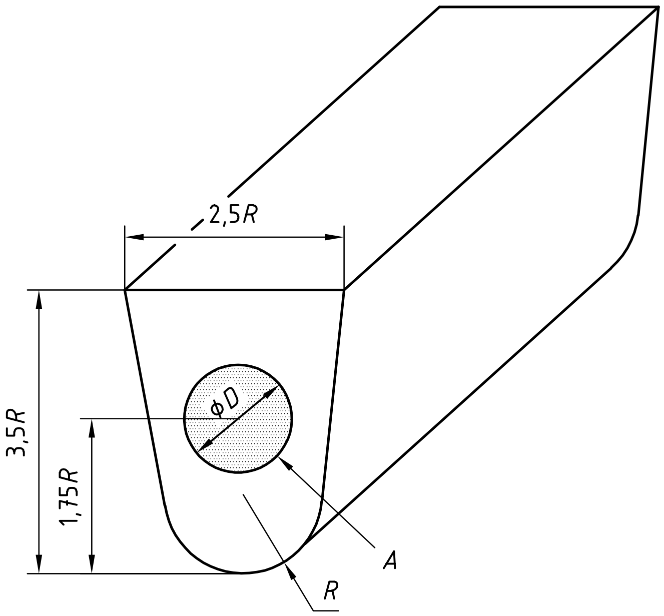
ER = 2,5t when D is $\leqslant$ 63,5 mm (2,5 in).

ER = 3,5t when D is $>$ 63,5 mm (2,5 in).

a When L is $< D$, consider as a plate of thickness t. When L is $< t$, consider as a plate of L thickness.

b Use maximum thickness, t, in the calculation.

Figure 2 — Equivalent round models — Tube (any section)



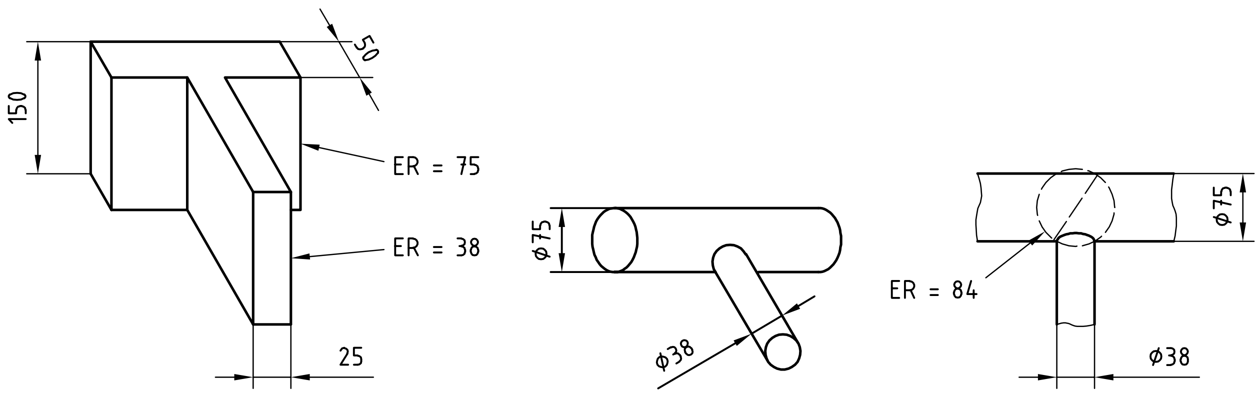
R = ER/2,3

D = 1,1R

NOTE Shaded area A indicates 1/4t envelope for test specimen removal.

Figure 3 — Equivalent round models — Keel block configuration

Dimensions in millimetres



a) Reduce to simple sections **b) ER values** **c) ER intersectional value**

The following steps should be used in determining the governing equivalent round (ER) for complex sections.

— Reduce the component to simple sections a).

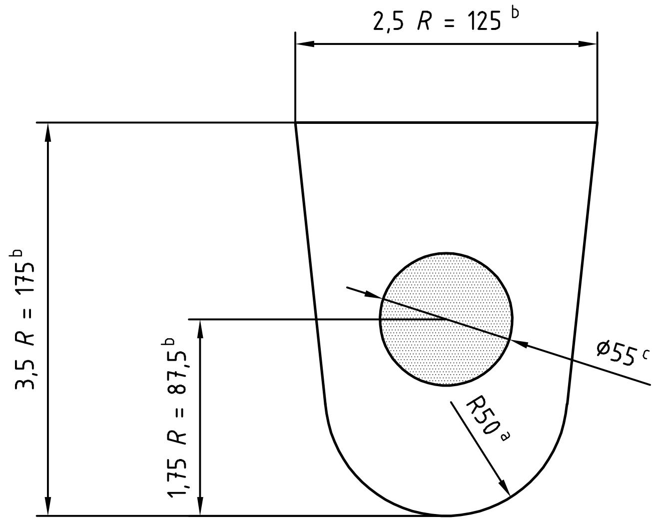
— Convert each simple section to an equivalent round b).

— Calculate the diagonal through the circle that would circumscribe the intersection of the ER values c).

Use the maximum ER value, whether for a single section or an intersection, as the ER of the complex section.

Figure 4 — Equivalent round models — Complex shapes

Dimensions in millimetres



To develop a keel block for ER = 115 mm:

a) noting from Figure 3 that *R* = ER/2,3 = 50 mm and *D* = 1,1*R*,

b) construct a keel block as illustrated in Figure 3 using multiples of *R*.

a *R* = ER/2,3 = 50 mm.

b Keel block dimensions.

c Diameter *D*.

Figure 5 — Development of keel block dimensions

7 Welding requirements

7.1 General

This clause describes requirements for the fabrication and repair welding of primary load-carrying and pressure-containing components, including attachment welds.

7.2 Welding qualification

All welding undertaken on components shall be performed using welding procedures that are qualified in accordance with ASME Section IX, AWS D1.1, and/or ASTM A 488. This welding shall only be carried out by welders or welding operators who are qualified in accordance with the aforementioned standards or EN 287.

Welding procedures for base materials that are not listed in the above standards shall be qualified individually or as a group based on weldability, tensile properties, or composition. Where the ductility of the parent metal is such as to render it incapable of meeting the bend test requirements of ASME IX, the bend test shall be conducted in the following manner: A bend bar comprised of parent metal heat treated to the ductility and strength requirements of the applicable specification shall be bent to failure. The side bend specimen taken from the weld test coupon shall then be capable of being bent to within 5° of the angle thus determined.

7.3 Written documentation

Welding shall be performed in accordance with welding procedure specifications (WPS) written and qualified in accordance with the applicable standard. The WPS shall describe all the essential, non-essential, and supplementary essential (when required) variables as listed in the applicable standard. Written prequalified welding procedures in accordance with the applicable standard may be used.

The procedure qualification record (PQR) shall record all essential and supplementary essential (when required) variables of the weld procedure used for the qualification tests. Both the WPS and the PQR shall be maintained as records in accordance with the requirements of Clause 11.

7.4 Control of consumables

Welding consumables shall conform to American Welding Society (AWS) or consumable manufacturer's specifications.

The manufacturer shall have a written procedure for storage and control of weld consumables. Materials of low hydrogen type shall be stored and used as recommended by the consumable manufacturer to retain their original low hydrogen properties.

7.5 Weld properties

The mechanical properties of the weld, as determined by the procedure qualification test, shall at least meet the minimum specified mechanical properties required by the design. When impact testing is required for the base material, it shall also be a procedure qualification requirement. Results of testing in the weld and base material heat-affected zone (HAZ) shall meet the minimum requirements of the base material. In the case of attachment welds, only the HAZ of material requiring impact testing shall meet the above requirements.

All weld testing shall be undertaken with the test weldment in the applicable post-weld heat-treated condition.

7.6 Post-weld heat treatment

Post-weld heat treatment of components shall be in accordance with the applicable qualified WPS.

7.7 Quality control requirements

Requirements for quality control of welds shall be in accordance with Clause 8.

7.8 Specific requirements — Fabrication welds

Weld joint types and sizes shall meet the manufacturer's design requirements and shall be documented in the manufacturer's WPS.

7.9 Specific requirements — Repair welds

7.9.1 Access

There shall be adequate access to evaluate, remove and inspect the nonconforming condition that is the cause of the repair.

7.9.2 Fusion

The selected WPS and the available access for repair shall be such as to ensure complete fusion with the base material.

7.9.3 Forgings and castings

All repair welding shall be performed in accordance with the manufacturer's written welding specifications. WPSs shall be documented and shall be supplied at the purchaser's request.

The manufacturer shall document the following criteria for permitted repairs:

- defect type;
- defect size limits;
- definition of major/minor repairs.

All excavations, prior to repair, and the subsequent weld repair shall meet the quality control requirements specified in Clause 8.

7.9.4 Heat treatment

The WPS used for qualifying a repair shall reflect the actual sequence of weld repair and heat treatment imparted to the repair item.

8 Quality control

8.1 General

This clause specifies the quality control requirements for equipment and material. All quality control work shall be controlled by the manufacturer's documented instructions, which shall include appropriate methodology, quantitative and qualitative acceptance criteria.

Instructions for NDE activities shall be sufficiently detailed regarding the requirements of this International Standard and those of all applicable referenced specifications. All NDE instructions shall be approved by an examiner qualified to an ASNT TC-1A level III examiner.

The acceptance status of all equipment, parts and materials shall be indicated either on the equipment, parts or materials or in the records traceable to the equipment, parts or materials.

8.2 Quality control personnel qualifications

NDE Personnel shall be qualified and/or certified in accordance with ASNT TC-1A.

Personnel performing visual inspection of welding operations and completed welds shall be qualified in accordance with:

- AWS QC1 or equivalent standard;

or

- the manufacturer's documented training programme (to be equivalent to above).

All personnel performing other quality control activities directly affecting material and product quality shall be qualified in accordance with the manufacturer's documented procedures.

8.3 Measuring and test equipment

Equipment used to inspect, test, or examine material or other equipment shall be identified, controlled, calibrated, and adjusted at specified intervals in accordance with documented manufacturer instructions, and consistent with a recognized industry standard (e.g. ISO 10012-1 [2], MIL STD 120 [10]), to maintain the required level of accuracy.

8.4 Quality control for specific equipment and components

8.4.1 General

The quality control requirements shall apply to all primary load-bearing and/or pressure-containing equipment and components unless specified otherwise.

The manufacturer shall establish and maintain critical area drawings identifying high stress areas, which shall be used in conjunction with this clause.

For purposes of this subclause, critical areas shall be defined as all areas where the stress in the component is:

$$\geqslant \frac{(0{,}75) \times S_{\text{Y min}}}{F_{\text{DS}}} \qquad (6)$$

where

S_{Ymin} is the specified minimum yield strength;

F_{DS} is the design safety factor.

If critical areas are not identified on critical area drawings, then all surfaces of the component shall be considered critical.

Areas of components in which the stress is compressive, and/or where the stress level is

$$\leqslant \frac{0{,}1\, S_{\text{Ymin}}}{F_{\text{DS}}} \qquad (7)$$

where

S_{Ymin} is the specified minimum yield strength;

F_{DS} is the design safety factor.

shall be exempt from the acceptance criteria defined in 8.4.7.4. The low stress areas thus defined may be identified on the critical area map.

8.4.2 Chemical analysis

Methods and acceptance criteria shall be in accordance with 6.6.

8.4.3 Tensile testing

Methods and acceptance criteria shall be in accordance with 6.3 and 6.4.

8.4.4 Impact testing

Methods and acceptance criteria shall be in accordance with 6.3 and 6.4.

8.4.5 Traceability

Components shall be traceable by heat, and heat-treatment lot, identification.

Identification shall be maintained on materials and components through all stages of manufacturing and on the finished components or assembly. Manufacturer's documented traceability requirements shall include provisions for maintenance and replacement of identification marks and identification control records. Fasteners and pipe fittings shall be exempt from the traceability requirements, provided they are marked in accordance with a recognized industry standard.

8.4.6 Visual examination

Components shall be visually examined. Visual examination of castings shall meet the requirements of MSS SP-55. Examination of wrought material shall be in accordance with the manufacturer's documented procedures.

8.4.7 Surface NDE

8.4.7.1 General

All accessible surfaces of each finished component shall be inspected in accordance with 8.4.7 after final heat-treatment and final machining operations.

If the equipment is subjected to a load test, the qualifying NDE shall be carried out after the load test. For materials susceptible to delayed cracking, as identified by the manufacturer, NDE shall be carried out no earlier than 24 h after the load test. The equipment shall be disassembled for this inspection. Conducting surface coatings shall be removed prior to examination. Non-conducting surface coatings shall be removed prior to examination unless it has been demonstrated that the smallest relevant indications, as defined in 8.4.7.3, can be detected through the maximum applied thickness of the coating.

8.4.7.2 Method

Ferromagnetic materials shall be examined by the magnetic particle method in accordance with ASME Section V, Sub-section A, Article 7, and Sub-section B, Article 25, or ASTM E 709. Machined surfaces shall be examined by the wet fluorescent method, other surfaces shall be examined by a wet method or dry method.

Non-ferromagnetic materials shall be examined by the liquid penetrant method in accordance with ASME Section V, Sub-section A, Article 6, and Sub-section B, Article 24, or ASTM E 165.

The use of prods should be avoided if possible. If prods are used, all prod burn marks shall be removed by grinding and the affected areas re-examined by the liquid penetrant method.

8.4.7.3 Evaluation of indications

Only those indications with major dimensions greater than 2 mm (1/16 in) and associated with a surface rupture shall be considered relevant. Inherent indications not associated with a surface rupture (i.e. magnetic permeability variations, non-metallic stringers, etc.) shall be considered non-relevant. If magnetic particle indications greater than 2 mm (1/16 in) are believed to be non-relevant, they shall either be examined by the liquid penetrant method to confirm they are non-relevant, or they shall be removed and re-inspected to confirm they are non-relevant.

Relevant indications shall be evaluated in accordance with the acceptance criteria specified in 8.4.7.4.

8.4.7.4 Acceptance criteria

8.4.7.4.1 Castings

ASTM E 125 shall be applied as a reference standard for the evaluation of magnetic particle indications on castings. The acceptance criteria shall be as specified in Table 2.

Table 2 — Castings indication acceptance criteria

Type	Discontinuity descriptions	Maximum permitted degree	
		Critical areas	Non-critical areas
I	Hot tears, cracks	None	Degree 1
II	Shrinkage	Degree 2	Degree 2
III	Inclusions	Degree 2	Degree 2
IV	Internal chills, chaplets	Degree 1	Degree 1
V	Porosity	Degree 1	Degree 2

8.4.7.4.2 Wrought materials

The following acceptance criteria shall apply for surface NDE of wrought materials:

— no relevant indications with a major dimension equal to or greater than 5 mm (3/16 in);

— no more than ten relevant indications in any continuous 40 cm^2 (6 in^2) area;

— no more than three relevant indications in a line separated by less than 2 mm (1/16 in) edge-to-edge;

— no relevant indications in pressure-sealing areas, in the root area of rotary threads or in the stress-relief features of threaded joints.

8.4.8 Volumetric NDE of castings

8.4.8.1 Method

Radiographic examination of castings shall be in accordance with ASME Section V, 1998, Sub-section A, Article 3, and Sub-section B, Article 22 with the restriction that fluorescent intensifying screens shall not be used.

Ultrasonic examination shall be in accordance with ASME Section V, 1998, Sub-section A, Article 5, and Sub-section B, Article 23. The component(s) shall be examined by the straight-beam method in accordance with SA-609 of Article 23 and shall be supplemented by angle beam examination as in T-510, T-520, T541.4.1, T-541.4.2 and T-542.4.3 of Article 5 in areas where a back reflection cannot be maintained during the straight-beam examination, or where the angle between the two surfaces of the component is more than 15°.

8.4.8.2 Sampling

Primary-load-carrying castings shall be examined by volumetric NDE on the following sampling basis as a minimum:

— all areas of initial or prototype castings shall be examined by ultrasonic or radiographic methods until the results of such examination indicate that a satisfactory production technique has been established;

— thereafter, one casting out of each production lot or, for production lots of less than ten castings, one out of every ten production castings, shall be volumetrically examined in all critical areas as identified on critical area drawings. If any casting shows any indications outside the acceptance criteria defined in 8.4.8.3, two more castings from that production lot shall be examined by the same method. If the two additional castings are acceptable, the remainder of the batch may be accepted and the initial non-conforming casting shall be repaired or scrapped.

8.4.8.3 Acceptance criteria

Areas of components where the stress level is less than the value of low stress [as calculated in Equation (7)] shall be exempt from volumetric examination.

a) Radiography

The acceptance criteria for radiographic examination are based on the Standard Reference Radiographs of ASTM E 446, ASTM E 186, or ASTM E 280 depending on the wall thickness being examined.

In all cases, cracks, hot tears and inserts (defect types D, E and F, respectively) are not permitted.

The remaining indication types shown in the reference radiographs shall meet Severity Level 2 in all critical areas and Severity Level 3 in non-critical areas. Critical areas shall be as defined in 8.4.1. If critical areas are not identified on critical-area drawings, then all areas of the component shall be considered critical.

b) Ultrasonic examination

The acceptance criteria for both straight-beam and angle-beam ultrasonic examination of castings are based on SA-609 in ASME Section V, 1998, Sub-section B, Article 23, Quality Level 3.

8.4.9 NDE of welds

8.4.9.1 General

If examination is required, essential welding variables and equipment shall be monitored during welding. The entire accessible weld, plus at least 13 mm (1/2 in) of surrounding base metal, shall be examined in accordance with the methods and acceptance criteria of 8.4.9.

The NDE required under 8.4.9 shall be carried out after final heat-treatment.

8.4.9.2 Fabrication welding

8.4.9.2.1 Visual examination

All fabrication welds shall be visually examined in accordance with ASME Section V, 1998, Sub-section A, Article 9. Undercuts shall not reduce the thickness in the affected area to below the design thickness, and shall be ground to blend smoothly with the surrounding material.

Surface porosity or exposed slag are not permitted on, or within 3 mm (1/8 in) of, sealing surfaces.

8.4.9.2.2 Surface NDE

All primary load-carrying and pressure-containing welds and attachment welds to primary load-carrying and pressure-containing components shall be examined as specified in 8.4.7.2.

The following acceptance criteria shall apply:

— no relevant, linear indications (see 3.1.8);

— no rounded indications (see 3.1.16) with a major dimension greater than 4 mm (1/8 in), for welds whose depth is 17 mm (5/8 in) or less;

— no rounded indications with a major dimension greater than 5 mm (3/16 in) for welds whose depth is greater than 17 mm (5/8 in);

— no more than three relevant indications in a line separated by less than 2 mm (1/16 in) edge-to-edge.

8.4.9.2.3 Volumetric NDE

Primary load-carrying welds and pressure-containing welds shall be examined by either ultrasonic or radiographic methods in accordance with ASME Section V, 1998, Sub-section A, Article 5 and Article 2 respectively.

This applies to full-penetration welds only.

Acceptance criteria shall be in accordance with the requirements of ASME Section VIII Div. 1, UW-51 and Appendix 12, as appropriate.

8.4.9.3 Repair welds

8.4.9.3.1 Weld excavations

Magnetic particle examination shall be performed on all excavations for weld repairs, with the method and acceptance criteria as specified in 8.4.7.

8.4.9.3.2 Repair welds in castings

All repair welds in castings shall be examined in accordance with 8.4.7.2. Acceptance criteria shall be identical to those for fabrication welds (see 8.4.9.2).

8.4.9.3.3 Repair of welds

NDE of the repairs of weld defects shall be identical to that of the original weld (see 8.4.9.2).

8.5 Dimensional verification

Verification of dimensions shall be carried out on a sample basis as defined and documented by the manufacturer.

All main load-bearing and pressure-sealing threads shall be gauged to the requirements of the relevant thread specification(s).

8.6 Proof load testing

When proof load testing is required, as indicated under the relevant equipment headings of Clause 9, the following requirements shall apply.

a) Each production unit or primary load-carrying component shall be load-tested in accordance with the requirements of this clause.

b) The equipment shall be mounted in a test fixture capable of loading the equipment in the same manner as in actual service and with the same areas of contact on the load-bearing surfaces. Rolling-element bearings that would be damaged by the test may be replaced by a load transfer device.

c) A test load equal to 1,5 times the rated load shall be applied and held for a period of not less than 5 min.

d) Following the load test, the design functions of the equipment shall be checked, as applicable. Proper functioning of the equipment shall not be impaired by the load test.

e) Assembled equipment shall be subsequently stripped down to a level that will permit full surface NDE of all primary load-bearing parts (excluding bearings).

f) All critical areas of the primary load-bearing parts shall be subjected to magnetic particle examination in conformance with 8.4.7.

Equipment normally exempt from load testing shall be given a proof load test if supplementary requirement SR1 (see Annex A) is specified in the order.

8.7 Hydrostatic testing

8.7.1 General

When hydrostatic testing is required, as indicated under the relevant equipment headings of Clause 9, the requirements of 8.7 shall apply.

8.7.2 Test sequence

The hydrostatic test shall be carried out in three steps:

a) the primary pressure-holding period;

b) the reduction of the pressure to zero;

c) the secondary pressure-holding period.

Both pressure-holding periods shall not be less than 3 min, the timing of which shall not start until the test pressure has been reached, the equipment and the pressure-monitoring gauge have been isolated from the pressure source, and the external surfaces of the body members have been thoroughly dried.

Specific hydrotesting requirements are included under the relevant equipment headings of Clause 9.

8.7.3 Calibrated pressure gauges

Calibrated pressure gauges and recording equipment shall be used during testing. Recorder graphs shall be signed, dated, and made traceable to the equipment being tested.

8.8 Functional testing

Specific functional testing requirements are included under the relevant equipment headings of Clause 9.

9 Equipment

9.1 General

The requirements of Clause 4 through Clause 8 apply to the primary load-carrying components of the covered equipment unless specifically noted otherwise. It is the equipment designer's responsibility to determine the primary load path through the equipment and to define primary load-carrying components.

Slip inserts and tong dies are exempt from testing, NDE, and traceability requirements of 6.3, 6.4, 6.5, 8.4, and 8.6.

9.2 Rotary tables

9.2.1 General

The requirements of 4.2.7, 5.4, 5.5, 5.6, 6.3.1, 8.4.4, 8.4.5, 8.4.7, and 8.4.8 shall not apply. For antifriction bearing design and manufacturing requirements, see 9.12.

9.2.2 Primary load

The primary load is the axial load through the centre of the rotary table. Rotary torque is not taken as a primary load.

9.2.3 Design verification function test

Design verification function test, as described in 5.2, shall apply.

9.2.4 Static load rating

The static load rating, or primary load rating, for a rotary table shall be equal to or less than the static load capacity of the main bearing.

9.2.5 Rotary table pinion-shaft extension

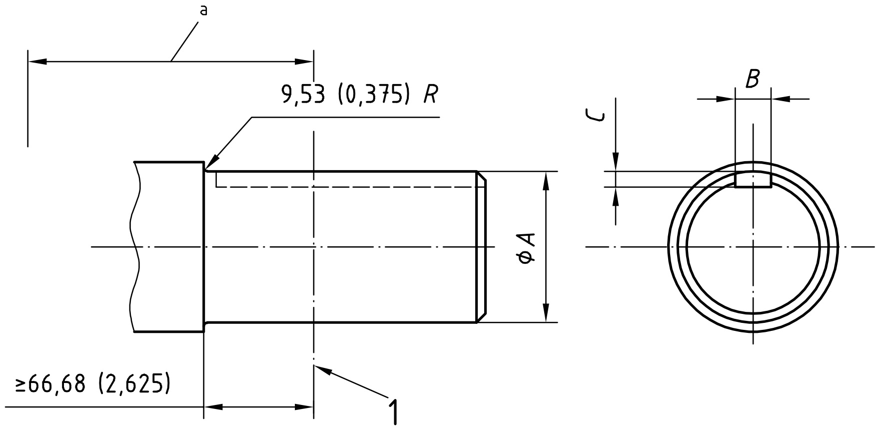
Rotary tables, with straight pinion-shaft extensions, shall be furnished in the sizes shown in Table 3 and shall conform to the dimensions and tolerances shown in Table 3 and Figure 6. This subclause does not preclude alternative drive input configurations (e.g. other straight or tapered pinion-shaft extensions, hydraulics drives, etc.).

Table 3 — Rotary table pinion-straight shaft extension
(see Figure 6 for illustration of dimension symbols)

Dimensions in millimetres (inches)

Size No.	Diameter of extension		Keyway			
			Width		Depth	
	A		*B*		*C*	
	$^{0}_{-0,025}$	$\left(^{0}_{-0,001}\right)$	$^{+0,025}_{0}$	$\left(^{+0,001}_{0}\right)$	$^{+1,52}_{0}$	$\left(^{+0,060}_{0}\right)$
1	82,55	(3,250)	19,05	(0,750)	6,35	(1/4)
2	100,03	(3,938)	25,40	(1,000)	9,52	(3/8)
3	107,95	(4,250)	25,40	(1,000)	9,52	(3/8)
4	114,30	(4,50)	25,40	(1,000)	9,52	(3/8)
5	125,43	(4,938)	31,75	(1,250)	11,11	(7/16)

Dimensions in millimetres (inches)



Key

1 centreline of first row of teeth (Figure 7)

a See Figure 7 and 9.2.6.

Figure 6 — Rotary table pinion-straight shaft extension (see Table 3 for dimensions)

9.2.6 Drive sprocket

The distance, L, between the centre of the rotary table and the centre of the first row of sprocket teeth (see Figure 7) shall be 1 353 mm (53 1/4 in) for machines that will pass a 510 mm (20 in) bit or larger, and shall be 1 118 mm (44 in) for machines that will not pass a 510 mm (20 in) bit, except that, by agreement between the manufacturer and purchaser, the distance of 1 353 mm (53 1/4 in) may be used on machines that will not pass a 510 mm (20 in) bit. The distance, L, shall be either 1 353 mm or 1 651 mm (53 1/4 in or 65 in) for the 1 257 mm (49 1/2 in) nominal rotary table. The distance, L, shall be 1 840 mm (72 in) for the 60 1/2 in nominal rotary table. These distances may be stamped on the name plate (if used) attached to the rotary table.

9.2.7 Rotary table openings

Rotary tables for use with square-drive master bushings shall conform to the requirements of Table 4 and Figure 8. Rotary tables for use with the four-pin-drive master bushings shall conform to the requirements in Table 5 and Figure 9. This subclause does not preclude rotary tables of other nominal sizes.

9.2.8 Demountable rotary table sprockets

Demountable rotary table sprockets are shown in Table 6 and Figure 10. The sprockets, both single-strand and double-strand, have a common bolt circle.

9.3 Rotary bushings

9.3.1 General

Rotary bushings and bushing adapters are included for the purpose of dimensional interchangeability only, and load rating is not required. The requirements of 6.3.1, 8.4.5, 8.4.7, 8.4.8 and 8.4.9 shall not apply.

9.3.2 Kelly bushings

Square-drive kelly bushings dimensions are shown in Figure 7.

Pin-drive kelly bushing dimensions are shown in Figure 9 and Table 5.

9.3.3 Master bushing

Square-drive master bushings and rotary table square-drive master bushings shall conform to the requirements of Table 4 and Figure 8. Dimensions for four-pin-drive master bushings shall conform to the requirements in Table 5 and Figure 9.

9.3.4 Bushing adapters

Bushing adapters are used to reduce the openings of rotary tables so that a smaller-size master bushing may be used.

9.4 Rotary slips

9.4.1 Rotary slips shall have a taper of 333,33 mm/m (4 in/ft) or 250 mm/m (3 in/ft) on the diameter, as applicable, and other suitable dimensions to permit operations in standard master bushings. Refer to 9.2.7 and Figure 7.

9.4.2 Load rating of rotary slips is not required.

9.4.3 The requirements of 8.4.4, 8.4.5, 8.4.8, and 8.4.9 shall not apply.

9.4.4 The requirements of 8.4.7 apply to rotary slips except that the method and acceptance criteria of MSS SP-53 shall apply.

9.5 Spiders not capable of use as elevators

9.5.1 General

Spider bodies furnished in conformance with this International Standard shall be marked with the manufacturer's name or mark and the rating.

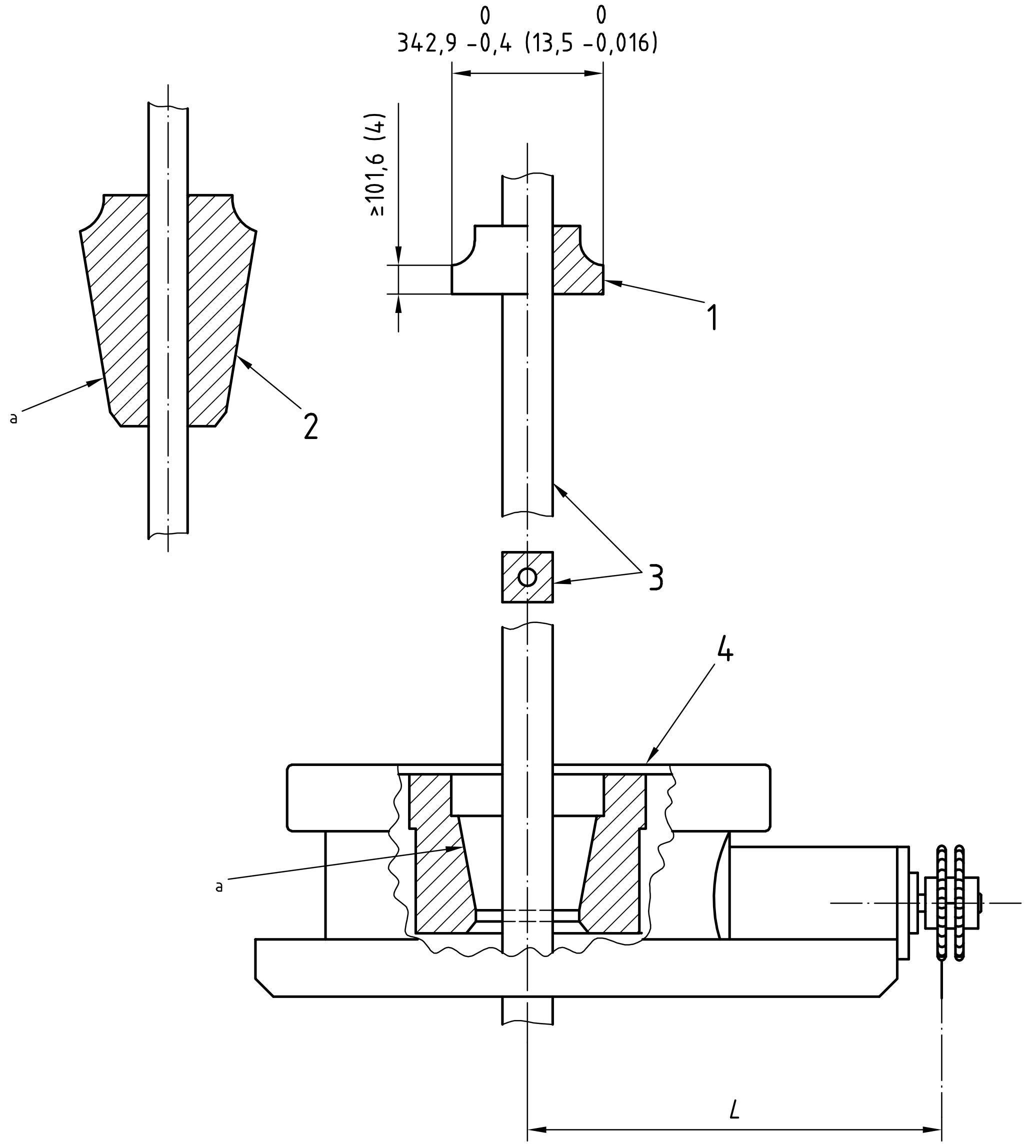
9.5.2 Component traceability

Primary load-carrying components shall be uniquely marked as specified in 8.4.5.

9.5.3 Serialization

Each complete item of equipment shall be marked with a unique serial number that shall provide traceability to its manufacturing history.

Dimensions in millimetres (inches)



Key

1 square-drive bushing removed from rotary table

2 pipe slips

3 kelly

4 cut-away showing master bushing

a (333,3 ± 1,5) mm/m [(4 ± 0,018) in/ft] taper on diameter.

Figure 7 — Rotary table with square-drive bushings (see 9.2.6 and 9.3.2 for description)

Table 4 — Rotary table opening and square-drive master bushing (see Figures 7 and 8 for illustration of symbols)

Dimensions in millimetres (inches)

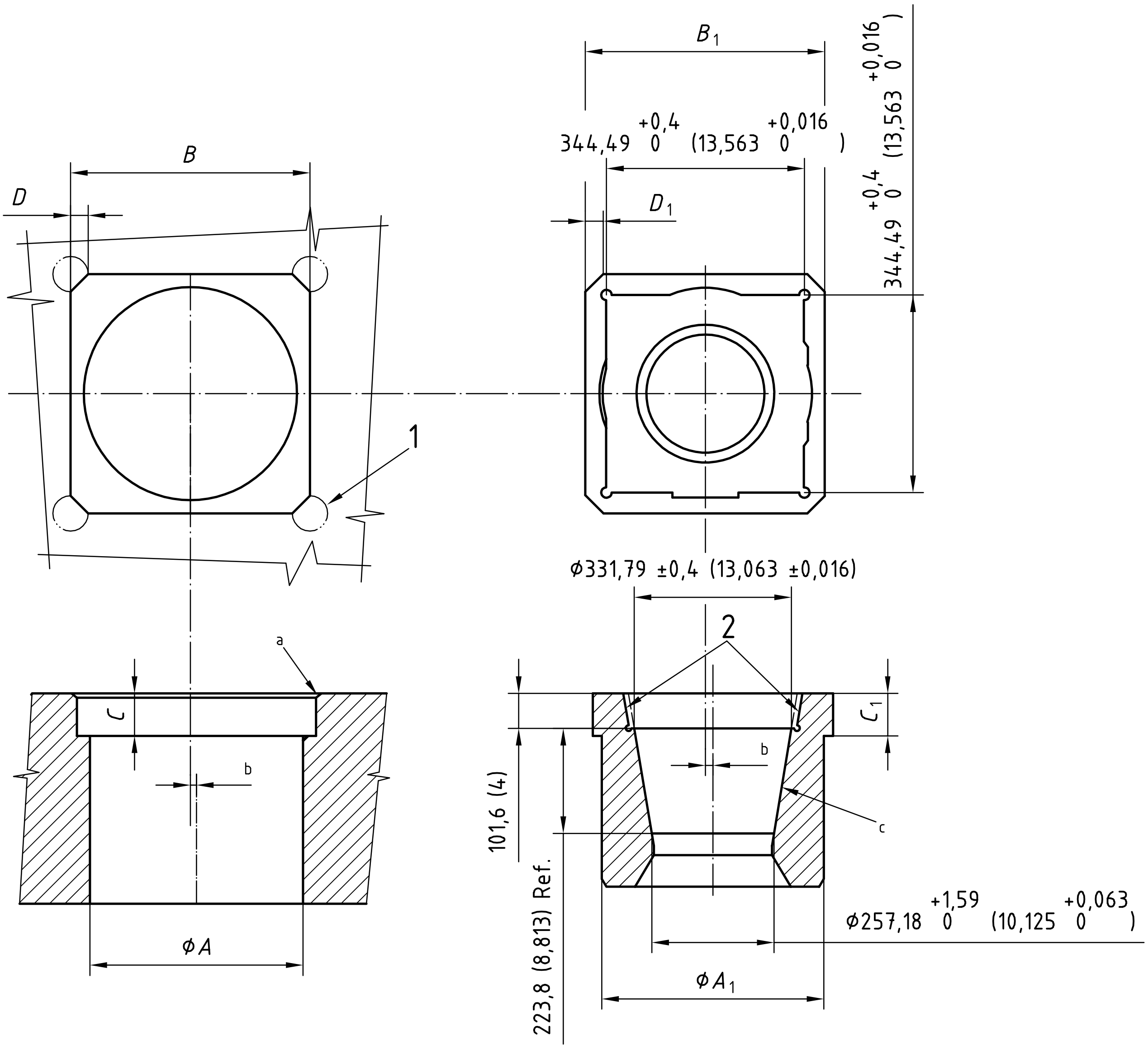
Nominal table size		Rotary table opening								Square-drive master bushing								Concentricity TIR	
		A		*B*		*C*		*D*		A_1		B_1		C_1		D_1			
		$^{+0,38}_{0}$	$\left(^{+0,015}_{0}\right)$	$^{+0,76}_{0}$	$\left(^{+0,030}_{0}\right)$			max.	max.	$^{0}_{-0,38}$	$\left(^{0}_{-0,015}\right)$	$^{0}_{-0,76}$	$\left(^{0}_{-0,030}\right)$			$^{+6,35}_{0}$	$\left(^{+0,250}_{0}\right)$		
(17 1/2)	444,5	444,50	(17 1/2)	461,96	(18 3/6)	133,3	5 1/4	44,45	(1 3/4)	442,91	(17 7/16)	460,38	(18 1/8)	133,35	(5 1/4)	44,45	(1 3/4)	0,79	(1/32)
(20 1/2)	520,7	520,70	(20 1/2)	538,16	(21 3/16)	133,3	5 1/4	44,45	(1 3/4)	519,11	(20 7/16)	536,58	(21 1/8)	133,35	(5 1/4)	44,45	(1 3/4)	0,79	(1/32)
(27 1/2)	698,5	698,50	(27 1/2)	715,96	(28 3/16)	133,3	5 1/4	44,45	(1 3/4)	696,91	(27 7/16)	712,79	(28 1/16)	133,35	(5 1/4)	44,45	(1 3/4)	0,79	(1/32)
(37 1/2)	952,5	952,50	(37 1/2)	—	—	—	—	—	—	950,91	(37 7/16)	—	—	—	—	—	—	—	—
(49 1/2)	1 257,3	1 257,30	(49 1/2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(60 1/2)	1 536,7	1 536,70	(60 1/2)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 5 — Four-pin-drive master bushing and kelly bushing (see Figure 9 for illustration of symbols)

Dimensions in millimetres (inches)

Nominal table size		*F*		*G*		*H*		*I*		*J*		*K*	
		± 1,59	(± 1/16)	± 0,13	(± 0,005)			± 0,13	(± 0,005)	$^{+1,59}_{0}$	$\left(^{+1/16}_{0}\right)$	$^{+1,59}_{0}$	$\left(^{+1/16}_{0}\right)$
(17 1/2)	444,5	482,60	(19)	65,15	(2,565)	107,95	(4 1/4)	62,79	(2,472)	365,13	(14 3/8)	257,18	(10 1/8)
(20 1/2)	520,7	584,20	(23)	65,15	(2,565)	107,95	(4 1/4)	62,79	(2,472)	365,13	(14 3/8)	257,18	(10 1/8)
(27 1/2)	698,5	654,05	(25 3/4)	86,23	(3,395)	107,95	(4 1/4)	82,93	(3,265)	365,13	(14 3/8)	257,18	(10 1/8)
(37 1/2)	952,5	654,05	(25 3/4)	86,23	(3,395)	107,95	(4 1/4)	82,93	(3,265)	365,13	(14 3/8)	257,18	(10 1/8)
(49 1/2)	1 257,3		—		—		—		—	365,13	(14 3/8)	257,18	(10 1/8)
(60 1/2)	1 536,7		—		—		—		—	365,13	(14 3/8)	257,18	(10 1/8)

Dimensions in millimetres (inches)



Key

1 optional relief

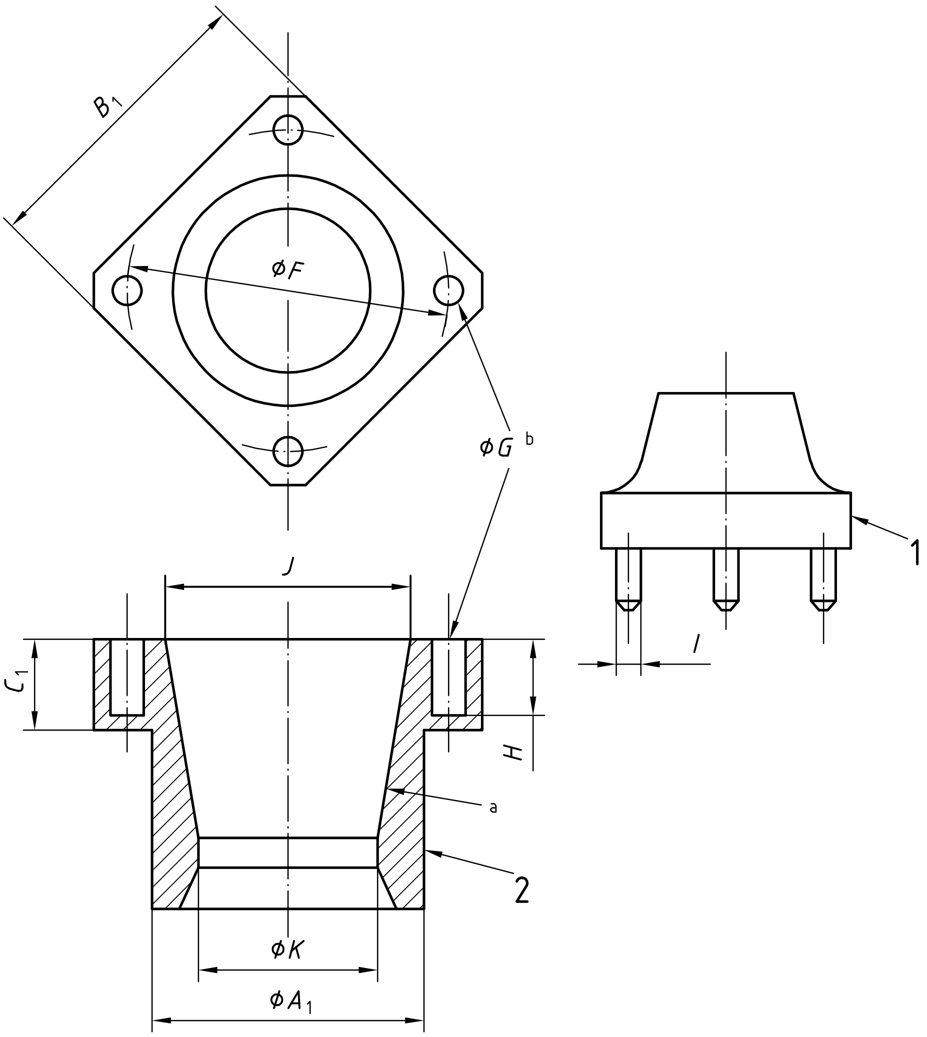
2 relief

a Chamfer ⩾ 6,35 mm (0,250 in) × 45°.

b ⩽ 0,40 mm (0,016 in) eccentricity.

c (333,33 ± 1,5) mm/m [(4 ± 0,018) in/ft] taper on diameter (9°27'45 “± 2'30” taper per side).

Figure 8 — Rotary table opening and square-drive master bushing
(see 9.2.7, 9.3.3 and Table 4 for dimensions)



Key

1 pin-drive kelly bushing

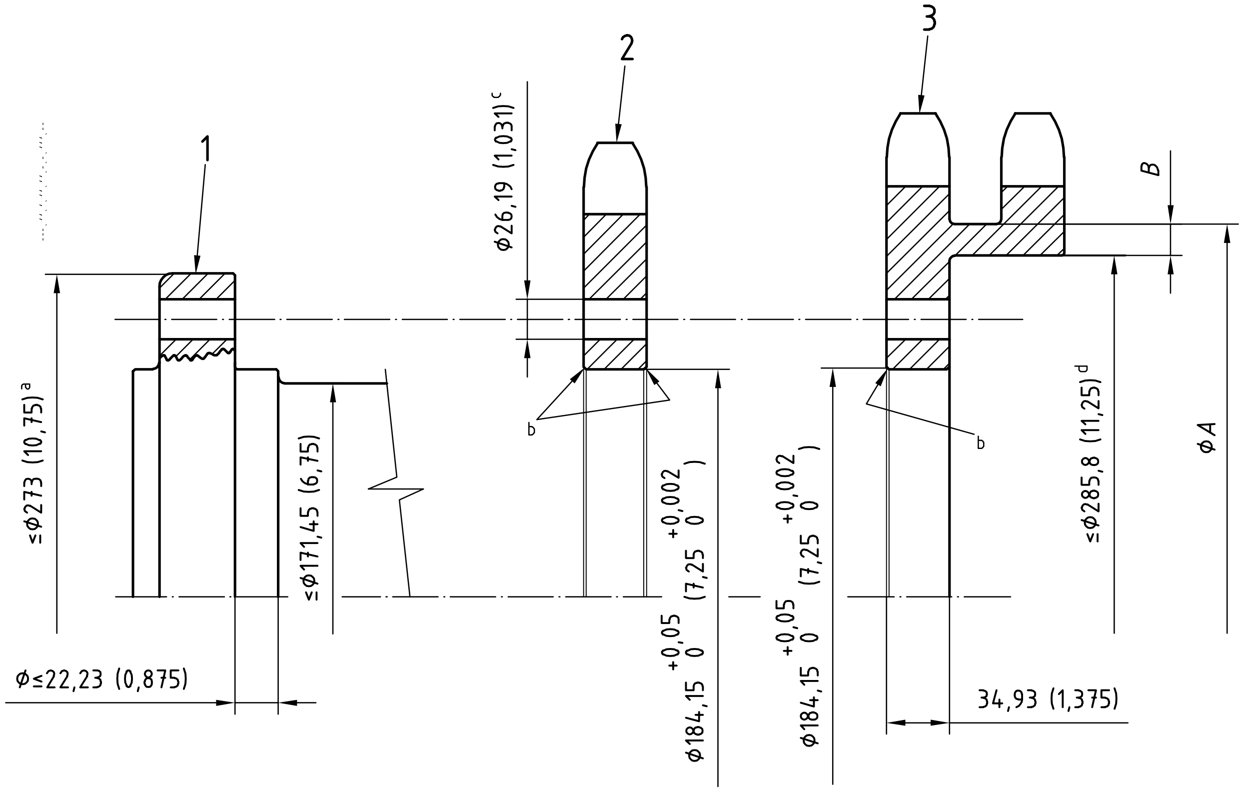
2 pin-drive master bushing

a (333,33 ± 1,5) mm/m [(4 ± 0,018) in/ft] taper on diameter (9°27'45 "± 2'30" taper per side).

b Diameter of drive hole.

Figure 9 — Pin-drive master bushing and kelly bushing
(see 9.2.7, 9.3.2, 9.3.3 and Tables 4 and 5 for dimensions)

Dimensions in millimetres (inches)



Key

1 hub

2 single sprocket

3 double sprocket

a Maximum hub diameter to allow for chain clearance.

b Chamfer 1,59 mm (0,063 in) × 45°.

c 8 holes equally spaced on 228,6 mm (9 in) bolt circle diameter.

d Applies to sprockets with minimum number of teeth. This can be increased for sprockets with more than the minimum number of teeth to as much as the dimensions A minus B.

Figure 10 — Demountable rotary sprocket (see 9.2.8 and Table 6 for dimensions)

Table 6 — Demountable rotary sprocket data (see 9.2.6, 9.2.8 and Figure 10 for explanation and illustration of symbols)

Sprocket type	Number of teeth on sprocket min.	Sprocket groove diameter max. *A*		Sprocket thickness at groove, minimum *B*	
		mm	(in)	mm	(in)
1 3/4 P single	23	—		—	
2 P single	21	—		—	
2 1/2 P single	17	—		—	
1 3/4 P double	25	306,39	(12 1/16)	10,32	(13/32)
2 P double	22	301,63	(11 7/8)	7,94	(5/16)
2 1/2 P double	19	315,91	(12 7/16)	15,08	(19/32)

9.5.4 Impact toughness

The following impact toughness values apply to spider bodies.

a) Components with a specified minimum yield strength of at least 310 MPa (45 000 psi) shall be made from materials possessing a minimum impact toughness of 33 J (25 ft-lbs) at −20 °C (−4 °F). The specified minimum impact toughness shall be an average of 3 tests, with no individual value less than 26 J (19 ft-lbs).

b) For components with a specified minimum yield strength of less than 310 MPa (45 000 psi), the −20 °C (−4 °F) minimum impact toughness shall be 27 J (20 ft-lbs) with no individual value less than 20 J (15 ft-lbs).

9.5.5 Design verification test

The design verification load test, as described in Clause 5, shall apply.

9.5.6 Proof load test

Proof load testing, as described in 8.6, shall apply.

9.6 Safety clamps not used as a hoisting device

9.6.1 Load rating of safety clamps is not required.

9.6.2 The requirements of 6.3.1, 8.4.4, 8.4.5, 8.4.8 and 8.4.9 shall not apply.

9.6.3 The requirements of 8.4.7 apply to safety clamps except that the method and acceptance criteria of MSS SP-53 shall apply.

9.7 Manual tongs

9.7.1 Product marking

Manual tongs furnished in conformance with this International Standard shall be marked with the manufacturer's name or mark and the rated load.

9.7.2 Size class designation

The size class designation for manual tongs shall represent the diameter, or range of diameters, for which the tong is designed.

9.7.3 Impact toughness

9.7.3.1 The following impact toughness values apply to primary load-path components except hinge pins.

a) Components with a specified minimum yield strength of at least 310 MPa (45 000 psi) shall be from materials possessing a minimum impact toughness of 42 J (31 ft-lbs) at −20 °C (−4 °F). The specified minimum impact toughness shall be an average of 3 tests, with no individual values less than 32 J (24 ft-lbs).

b) For components with a specified minimum yield strength of less than 310 MPa (45 000 psi), the −20 °C (−4 °F) minimum impact toughness shall be 27 J (20 ft-lbs) with no individual values less than 20 J (15 ft-lbs).

9.7.3.2 Hinge pins shall have a minimum impact toughness of 15 J (11 ft-lbs) at −20 °C (−4 °F). The specified minimum impact toughness shall be an average of 3 tests, with no individual value less than 12 J (8,5 ft-lbs).

9.7.4 Component traceability

Primary load-carrying components shall be uniquely marked as specified in 8.4.5.

9.7.5 Design verification load tests

The design verification load test, as described in Clause 5, shall apply.

9.7.6 Proof load testing

Proof load testing, as described in 8.6, shall apply. Jaw hinge pins of wrought material shall be exempt from this requirement.

9.8 Power tongs

9.8.1 Product marking

Power tongs furnished in conformance with this International Standard shall be marked with the manufacturer's name or mark and size class.

9.8.2 Size class designation

The size class designation for power tongs shall represent the diameter, or range of diameters, for which the tong is designed.

9.8.3 Requirements

The requirements of 4.2.7, 5.3, 5.4, 5.5, 5.6, 6.3 and Clause 8 in its entirety shall not apply.

9.8.4 Primary load path

The primary load path shall be considered to be the mechanical elements (exclusive of hydraulic power transmission components) through which the torque is applied or resisted.

9.9 Drawworks components

9.9.1 Primary load path

The primary load-path components for a drawworks shall be limited to those loaded by the fast-line load when the main drum brake is engaged. The manufacturer/designer shall use accepted design practices and shall determine factors of safety, except as otherwise specified within this International Standard.

9.9.2 Requirements

The requirements of 4.2.7, 5.4, 5.5, 5.6, 6.3.1, 8.4.4, 8.4.5, 8.4.7, and 8.4.8 shall not apply, except as noted below. For antifriction bearing design and manufacturing requirements, see 9.12.

9.9.3 Line-shaft extension for cathead

Line-shaft extensions for catheads shall be furnished as specified on the purchase order unless the drawworks is furnished with integral catheads.

9.9.4 Brake bands for main drum

9.9.4.1 General

Main drum brakes are generally band or disk types, but other designs are not precluded by this International Standard.

9.9.4.2 Design safety factor

The minimum design safety factor for the structural strength of main drum brake bands shall be 3,0, based on the drawworks' rated design fast-line pull at the median drum working radius, or the second layer of working rope, whichever is greater.

9.9.4.3 Weldments

9.9.4.3.1 The design load capacity of the weldment shall not be less than the minimum design load capacity of the band only.

9.9.4.3.2 Weldments shall be reviewed for the effect of weld stress concentration as it affects fatigue life of the weldments.

9.9.4.4 Quality control

9.9.4.4.1 All castings and welds shall be inspected in accordance with 8.4.7.

9.9.4.4.2 All accessible surfaces of the band shall be visually inspected after all manufacturing operations are completed. Indications with a length of less than three times the width are acceptable, provided the major dimension is less than 4 mm (1/8 in) and they meet other criteria established in 8.4.7.4 for wrought material. No indications with a length equal to or greater than three times the width are acceptable. No indications at the edges, including hole edges, of the band are acceptable.

9.9.4.4.3 The inside radius on a band, between tangent points, shall not deviate more than ± 0,5 % from the design radius. The inside radii measured at the edges of a band at any circumferential point on the band shall not vary more than ± 0,5 % of the band width at that point.

9.9.4.4.4 Maximum allowable weld undercut shall be in accordance with AWS D1.1, except that there shall be none for any transverse welds.

9.10 Rotary hose

9.10.1 Application

Rotary drilling hose is used as the flexible connector between the top of the standpipe and the swivel that allows for vertical travel. It is usually used in lengths of 13,5 m (45 ft) or longer.

Rotary vibrator hose is used as a flexible connector between the mud-pump manifold and the standpipe manifold to accommodate alignment and isolate vibration. These hoses are usually used in lengths of 9 m (30 ft) and less.

9.10.2 Primary load

The primary load for a rotary hose shall be taken as the internal pressure.

9.10.3 Requirements

The requirements of 4.2.7, and all paragraphs of Clause 5, Clause 6, Clause 7, and Clause 8 shall not apply.

9.10.4 Sizes

Rotary drilling hose and rotary vibrator hose shall be furnished in the sizes listed in Table 7 as specified on the purchase order. Lengths shall be specified on the purchase order in 1,5 m (5 ft) increments.

9.10.5 Dimensions

Dimensions of rotary hose shall conform to the requirements of Table 7 and Figure 11, except as noted in 9.10.4.

9.10.6 Connections

Rotary hose assemblies furnished with external connections threaded with line-pipe threads shall have threads as specified in API Spec 5B. The marking “ISO 14693” may be retained on the hose assemblies when other connections are applied, upon agreement of the user and the manufacturer, and if the assembly is pressure-tested in accordance with Table 7 with the connections in place.

9.10.7 Test pressure

Each hose assembly shall be individually tested at the applicable pressure specified in Table 7 and held for a minimum period of 1 min.

9.10.8 Working pressure

The maximum working pressure of the hose assembly shall be that shown in Table 7. The surge pressures encountered in the system shall be included in the working pressure. The hose shall be designed to have a minimum burst pressure of at least 2 1/2 times the working pressure.

9.10.9 Marking

The hose assembly conforming to this International Standard shall be marked with ISO 14693, the working pressure, and the manufacturer's identification. Additionally, when the hose manufacturer does not install safety clamps, each hose end shall be marked (at the locations specified in Figure 11) with the notation “Attach safety clamp here.” Each length of hose shall have a longitudinal lay line of a colour different than the hose cover. Markings, whether embossed or printed in distinctive colours, shall be vulcanized or similarly affixed into the hose cover.

9.11 Piston mud-pump components

9.11.1 General

9.11.1.1 The primary load-bearing components for a mud pump shall be defined as those containing the discharge pressure, with the exception of expendable items and closure components such as liners, pistons, piston rods, packing, packing glands, valves and seats, covers, heads, clamps, bushings, plugs, and fasteners.

The requirements of 4.2.7, 5.3, 5.4, 5.5, 5.6, 6.3.1, 8.4.4, 8.4.5, 8.4.7 and 8.4.8 shall not apply. For antifriction bearing design and manufacturing requirements, see 9.12.

9.11.1.2 Pressure-rated items, as defined in 9.11.1.1, shall be pressure-tested in production to 1,5 times the working pressure. Hydrostatic testing shall be performed in accordance with 8.7.

9.11.1.3 Cast components of the mud-pump suction hydraulic circuit shall be hydrostatically tested in production to twice the manufacturer's rated suction pressure. The test procedure shall be the same as for discharge components described in 9.11.1.2.

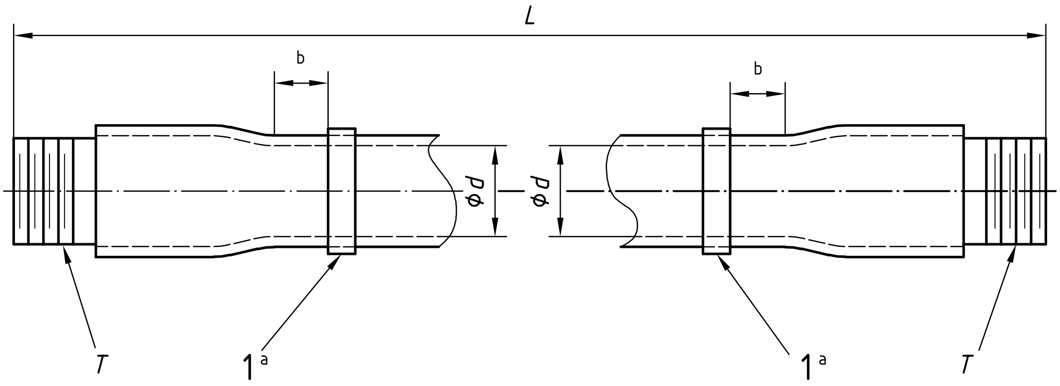
9.11.2 Mud-pump piston rod and piston body bore, fluid end (see Annex D for guidance on mud-pump nomenclature)

9.11.2.1 Sizes and dimensions

For double-acting pumps, fluid ends of mud-pump piston rods and bores of piston bodies shall be in accordance with Table 8 and Figure 12 and Figure 13. For single-acting pumps, the fluid ends of the piston rods and bores of the piston bodies shall conform to Table 9 and Figure 14.

Table 7 — Rotary vibrator and drilling hose dimensions and pressures
(see Figure 11 for illustration of symbols)
(see Table C.1 for US customary units)

Inside diam. (size)		**Thread or flange size**		**Working pressure** MPa					**Test pressure** MPa				
d		*T*		Grade	Grade	Grade	Grade	Grade	Grade	Grade	Grade	Grade	Grade
(in)	mm	mm	(in)	A	B	C	D	E	A	B	C	D	E
(2)	50,8	63,5	(2 1/2)	10,3	13,8	27,6	—	—	20,7	27,6	55,2	—	—
(2 1/2)	63,5	76,2	(3)	10,3	13,8	27,6	34,5	51,7	20,7	27,6	55,2	69,0	103,4
(3)	76,2	101,6	(4)	—	—	27,6	34,5	51,7	—	—	55,2	69,0	103,4
(3 1/2)	88,9	101,6	(4)	—	—	27,6	34,5	51,7	—	—	55,2	69,0	103,4
(4)	101,6	127,0	(5)	—	—	27,6	34,5	51,7	—	—	55,2	69,0	103,4
(5)	127	127,0	(5)	—	—	27,6	34,5	51,7	—	—	55,2	69,0	103,4



Key

1 safety clamp

L nominal length

[a] Hose manufacturers shall mark the hose with the notation “Attach safety clamp here.”

[b] For rotary drilling hose, this dimension shall be 150 mm (6 in) to 460 mm (18 in) from the inboard end of the coupling. For vibrator hose, this dimension shall be 150 mm (6 in) to 250 mm (10 in) from the inboard end of the coupling.

Figure 11 — Rotary vibrator and drilling hose dimensions (see Table 7 for dimensions)

Table 8 — Fluid end of double-acting mud-pump piston rods and piston body bores

(see Figure 12 and Figure 13 for illustration of dimension symbols) (see Table C.2 for US customary units)

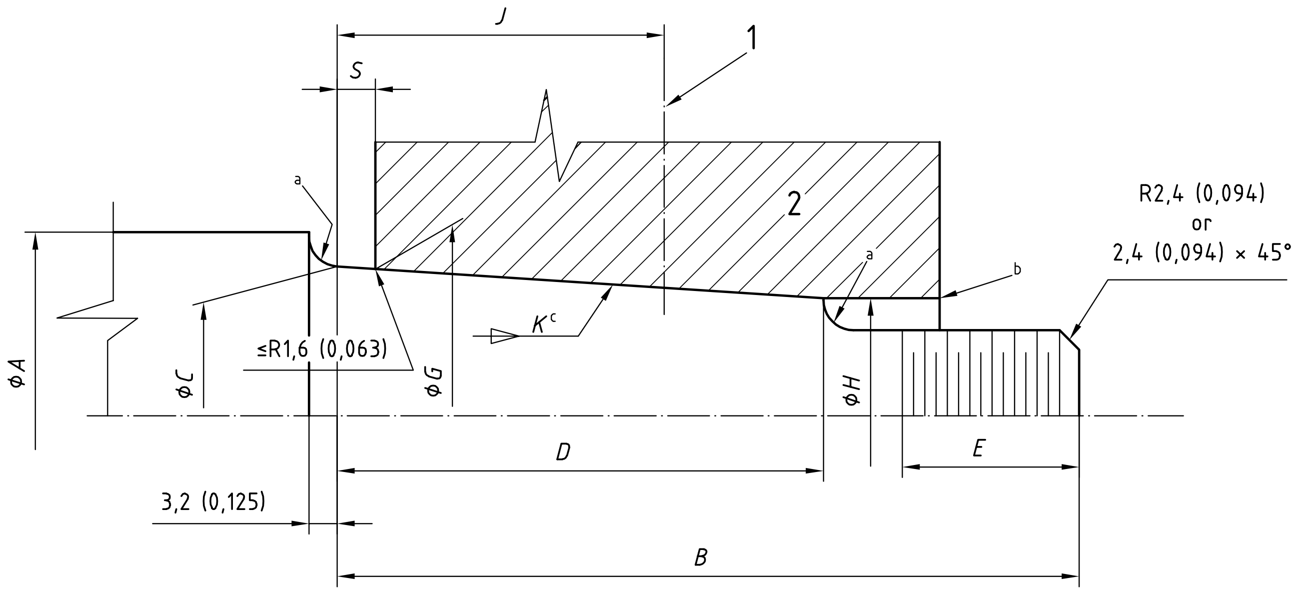
Dimensions in millimetres

Piston and rod taper No.	Rod diam range[a]	Piston rod: Length of rod end	Piston rod: Major diam. rod taper	Piston rod: Length of taper	Piston rod: Length of perfect thread	Piston: Diam. of thread boss	Piston: Gauge point piston diam.	Piston: Diameter of cylindrical bore	Piston: Centre of piston	Piston and rod taper mm/m on diameter	Standoff *S*		Thread designation
		± 1,6	± 0,03	± 1,6	± 3,2	$^{0}_{-1,6}$	± 0,05	± 0,40		± 0,05			
	A	*B*	*C*	*D*	*E*	*F*	*G*[c]	*H*	*J*	*K*	min.	max.	
1	25,4 to 31,0	98,4	25,40	38,1	44,5	—	24,87	23,0	34,9	83,33	6,4	—	7/8-9UNC-2A
2	31,8 to 37,3	130,2	31,75	63,5	60,3	—	31,22	26,2	47,6	83,33	6,4	—	1-8UNC-2A
3	38,1 to 46,8	181,0	38,10	60,3	88,9	—	37,44	32,5	68,3	104,17	6,4	—	1 1/4-8UN-2A
4	47,6 to 56,4	203,2	47,63	101,6	88,9	—	47,09	39,7	74,6	83,33	6,4	—	1 1/2-8UN-2A
5	57,2 to 69,1	219,1	57,15	101,6	104,8	—	56,62	49,2	74,6	83,33	6,4	—	1 7/8-8UN-2A
6	69,9 to 75,4	231,8	69,85	114,3	104,8	—	69,32	60,3	74,6	83,33	6,4	—	2 1/4-8UN-2A
5HP[b]	69,9 to 88,9	219,1	57,15	95,3	111,1	42,9	56,62	49,2	68,3	83,33	1,04	2,87	1 7/8-8UN-2A
6HP	76,2 to 88,9	231,8	69,22	108,0	111,1	52,4	69,32	60,3	68,3	83,33	1,04	2,87	2 1/4-8UN-2A

[a] Selected diameter tolerances for ISO/API rod numbers 1 and 2: $^{+0,25}_{-0,13}$ mm. For rod number 3 and larger: $^{+0,25}_{0}$ mm.

[b] Recommended as a substitute for ISO/API 6HP piston for reduced liner sizes only.

[c] Dimension *G* relates to dimension *S*, min. only (standoff).



Key

1 centreline of piston (hand-tight position)

2 piston

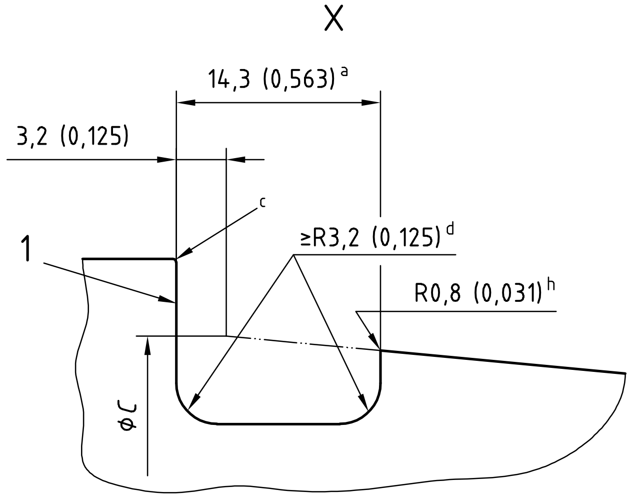
a 3,2 mm (0,125 in) *R* at each shoulder

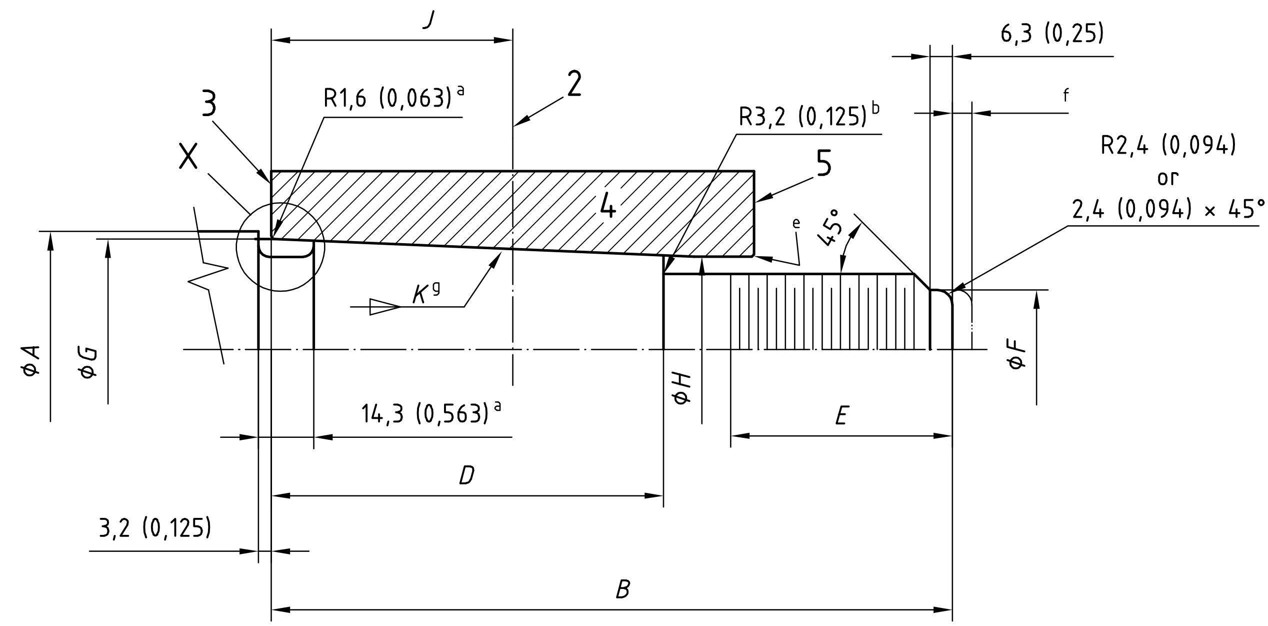
b Break corner

c Taper

Figure 12 — Tapers 1 through 6 (see Table 8 for dimensions)

Dimensions in millimetres (inches)





Key

1 shoulder M, rod shoulder

2 centreline of piston (hand-tight position)

3 shoulder N, piston shoulder, rod end

4 piston

5 shoulder P, piston shoulder, thread end

a Maximum dimension.

b Minimum dimension.

c Break ⩽ 0,4 mm (0,016 in).

d Fillets and undercut diameter to be prestressed by coldworking.

e Break corner.

f Maximum optional end extension 3,2 mm (0,125 in).

g Taper.

h Radius or break corner.

Figure 13 — Tapers 5 HP and 6 HP (see Table 8 for dimensions)

9.11.2.2 Threads

Threads on rod ends and in retainer nuts shall conform to the dimensions given in Table 8 and Table 9, and shall be controlled by Class X gauges conforming to the stipulations in ANSI B1.2. If supplementary production or working gauges are used, they shall be accurate copies of the master gauges.

9.11.2.3 Piston and rod shoulders

For 5 HP, 6 HP and single-acting pistons, shoulder faces M and N of pistons and rods shall be square to the centreline within 0,03 mm (0,001 in) total indicator reading (TIR). Piston shoulder face, P, shall be square to the centreline within 0,13 mm (0,005 in) TIR.

9.11.2.4 Marking

Marking shall be as follows.

a) Pistons, double-acting, with a taper conforming to this International Standard shall be marked with the manufacturer's name or mark, and the taper number. High-pressure pistons numbered 5 HP and 6 HP are dimensionally interchangeable with pistons 5 and 6. It is permissible to stamp both tapers on shoulder P.

b) Pistons, single-acting, with straight bores conforming to this International Standard shall be marked with the manufacturer's name or mark, ISO 14693 and the connection number.

c) Piston rods, double-acting, conforming to this International Standard shall be marked with the manufacturer's name or mark, ISO 14693 and the taper number. The crosshead extension end of the piston rod shall be marked with ISO 14693 and the taper thread number or the straight thread number from Table 10 or Table 11.

d) Piston rods, single-acting, conforming to this International Standard on the fluid end shall be marked with the manufacturer's name or mark, ISO 14693, and the connection number. If the crosshead extension end of the piston rod conforms to 9.11.3.1 or 9.11.3.2, this end shall be marked with ISO 14693 and the taper thread number or the straight thread number from Table 10 or Table 11.

9.11.3 Duplex mud-pump crosshead, crosshead extension, and piston rod connections — Tapered thread type

9.11.3.1 Sizes

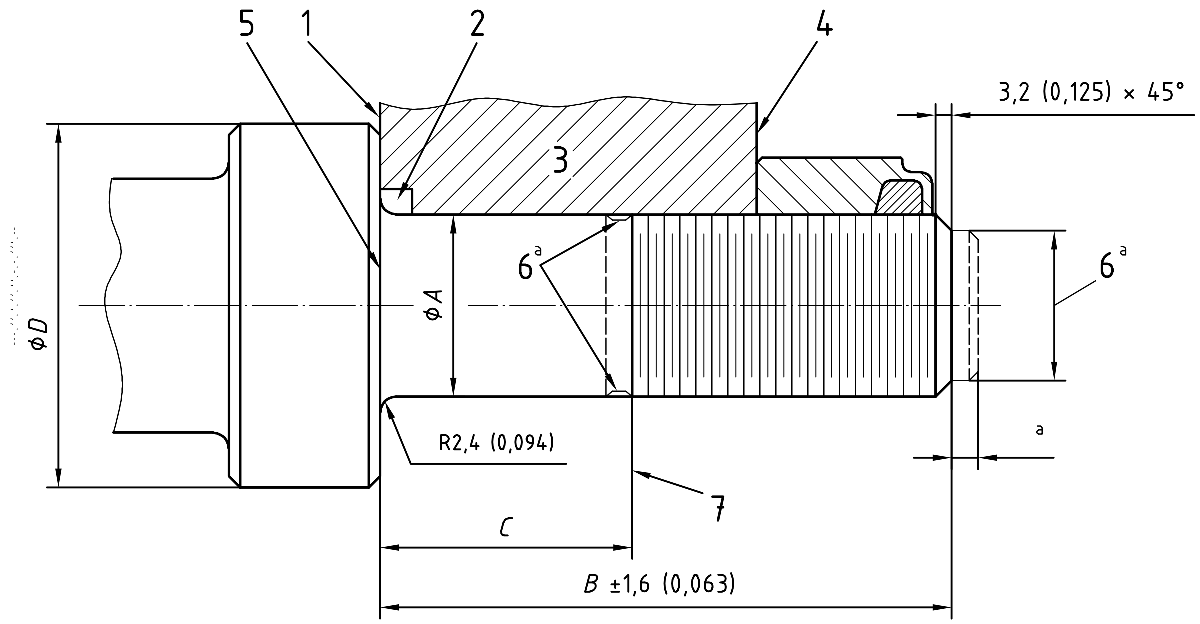
Tapered thread type connections between crossheads, crosshead extensions and piston rods shall be 8 TPI, Series UN, Class 2A-2B modified, in the sizes given in Table 10. Requirements for gauges and gauging practice are given in 9.11.3 and 9.11.4.

Table 9 — Fluid end of single-acting mud-pump piston rods and piston body bores
(see Figure 14 for illustration of dimension symbols)
(see Table C.3 for US Customary units)

Dimensions in millimetres

Piston and rod connection number	Connection diameter, nominal		Piston rod					Piston bore
			Rod diameter	Length rod end ± 1,6	Start of thread from shoulder max.	Shoulder diameter ± 0,4	Thread designation	
	mm	(in)	*A*	*B*	*C*	*D*		
SA-2	25,4	(1)	25,32 to 25,38	106,4	38,1	50,8	1-8UNC-2A	25,40 to 25,48
SA-4	38,1	(1 1/2)	38,02 to 38,07	138,1	47,6	82,6	1 1/2-8UN-2A	38,10 to 38,18

Dimensions in millimetres (inches)



Key

1 shoulder N, piston shoulder, rod end
2 seal required, dimensions are the option of manufacturer
3 piston
4 shoulder P, piston shoulder, thread end
5 shoulder M, rod shoulder
6 thread relief feature, details at option of manufacturer
7 last full thread

a Optional feature.

Figure 14 — Fluid end of single-acting mud-pump piston rod and piston body bore
(see Table 9 for dimensions)

9.11.3.2 Thread dimensions and tolerances

Tapered thread type connections shall conform to dimensions given in Table 10, Figure 15 and Figure 16 and the following tolerances:

a) **Taper**: tapered threads shall have a taper of 166,67 mm/m (2 in/ft) on the pitch cone diameter with a tolerance of $\left(^{\ \ 0}_{-0,51}\right)$ mm $\left[\left(^{\ \ 0}_{-0,020}\right)\text{in}\right]$ for internal threads and $\left(^{+0,51}_{\ \ 0}\right)$ mm $\left[\left(^{+0,020}_{\ \ 0}\right)\text{in}\right]$ for external threads.

b) **Concentricity**: threads shall be concentric with rod design axis. Angular misalignment of thread axis with rod design axis shall not exceed 0,5 mm/m (0,000 5 in/in) of length.

c) Length:

$$L_{\text{ET}} = B + C \tag{8}$$

$$B = 1{,}25 \times A \tag{9}$$

where

L_{ET} is the total length of external threads (see Figure 15 for A, B and C).

d) **Perpendicularity**: face of internal thread member shall be perpendicular to thread axis within 0,001 mm/mm (0,001 in/in) of face diameter.

e) **Lead**: lead tolerance shall be ± 0,002 2 mm/mm (± 0,002 2 in/in). Cumulative lead tolerance shall be ± 0,056 mm (± 0,002 2 in).

f) **Thread angle**: half-angle tolerance of thread angle shall be ± 1°.

g) **Truncation**: crest on both internal and external threads shall be truncated parallel to taper to produce a flat 0,76 mm (0,030 in) wide. Root on both internal and external threads shall be truncated parallel to thread axis to produce a flat of width 0,38 mm (0,015 in). Roots of internal threads may be truncated parallel to taper of thread at the option of manufacturer. Straight threads are to be truncated the same as tapered threads.

h) **Pitch diameter**: pitch diameter and pitch diameter tolerance of straight threads shall be as designated in Table 4.1, ANSI B1.1.

i) **Standoff**: in gauging tapered threads, standoff of product from plain and threaded plug and ring gauges shall be maintained within a tolerance of ± 1,6 mm (± 1/16 in) (see Figure 22).

CAUTION — Do not damage threads , as this will cause misalignment and failure.

9.11.3.3 Locknuts

Crosshead extension and piston rod locknuts shall be furnished in accordance with 9.11.3.2 and Figure 17.

9.11.4 Duplex mud-pump crosshead, crosshead extension, and piston rod connections — straight thread type

9.11.4.1 Sizes

Straight thread type connections between crossheads, crosshead extensions, and piston rods shall be 8 TPI, Series UN, Class 2A-2B modified, in the sizes given in Table 11.

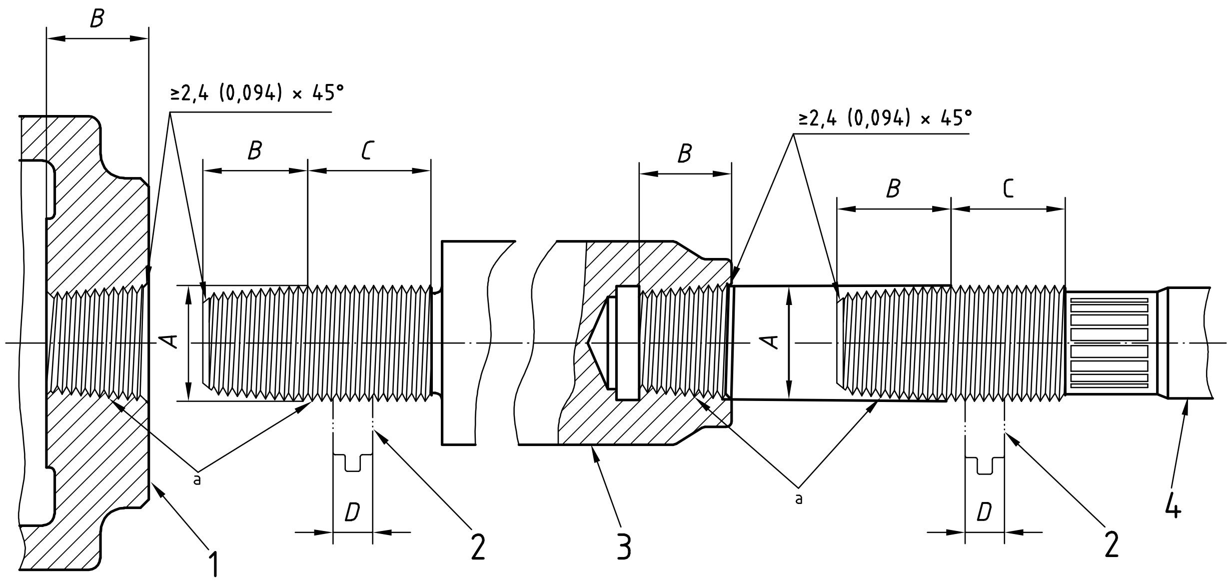
Table 10 — Crosshead, crosshead extension, and piston rod connections — Tapered thread type
(see Figure 15 for illustration of dimension symbols)

Dimensions in millimetres (inches)

Taper thread number	Nominal size *A*[a]		Taper thread *B*		Length of straight thread *C*		Locknut thickness *D*	
T1	25,4	(1)	31,8	(1 1/4)	25,4	(1)	19,1	(3/4)
T2	28,6	(1 1/8)	35,7	(1 13/32)	25,4	(1)	19,1	(3/4)
T3	31,8	(1 1/4)	39,7	(1 9/16)	25,4	(1)	22,2	(7/8)
T4	34,9	(1 3/8)	43,7	(1 23/32)	25,4	(1)	22,2	(7/8)
T5	38,1	(1 1/2)	47,6	(1 7/8)	31,8	(1 1/4)	25,4	(1)
T6	41,3	(1 5/8)	51,6	(2 1/32)	31,8	(1 1/4)	25,4	(1)
T7	44,5	(1 3/4)	55,6	(2 3/16)	31,8	(1 1/4)	28,6	(1 1/8)
T8	47,6	(1 7/8)	59,5	(2 11/32)	31,8	(1 1/4)	28,6	(1 1/8)
T9	50,8	(2)	63,5	(2 1/2)	38,1	(1 1/2)	31,8	(1 1/4)
T10	57,2	(2 1/4)	71,4	(2 13/16)	38,1	(1 1/2)	34,9	(1 3/8)
T11	63,5	(2 1/2)	79,4	(3 1/8)	44,5	(1 3/4)	38,1	(1 1/2)
T12	69,9	(2 3/4)	87,3	(3 7/16)	44,5	(1 3/4)	41,3	(1 5/8)
T13	76,2	(3)	95,3	(3 3/4)	50,8	(2)	44,5	(1 3/4)
T14	82,6	(3 1/4)	103,2	(4 1/16)	50,8	(2)	47,6	(1 7/8)
T15	88,9	(3 1/2)	111,1	(4 3/8)	57,2	(2 1/4)	50,8	(2)
T16	101,6	(4)	127,0	(5)	57,2	(2 1/4)	50,8	(2)
T17	114,3	(4 1/2)	142,9	(5 3/8)	57,2	(2 1/4)	50,8	(2)
T18	127,0	(5)	158,8	(6 1/4)	57,2	(2 1/4)	50,8	(2)
T19	139,7	(5 1/2)	174,6	(6 7/8)	57,2	(2 1/4)	50,8	(2)
T20	152,4	(6)	190,5	(7 1/2)	57,2	(2 1/4)	50,8	(2)

[a] All threads are 8TPI, series UN, class 2A-2B modified.

Dimensions in millimetres (inches)



Key

1 crosshead

2 locknut

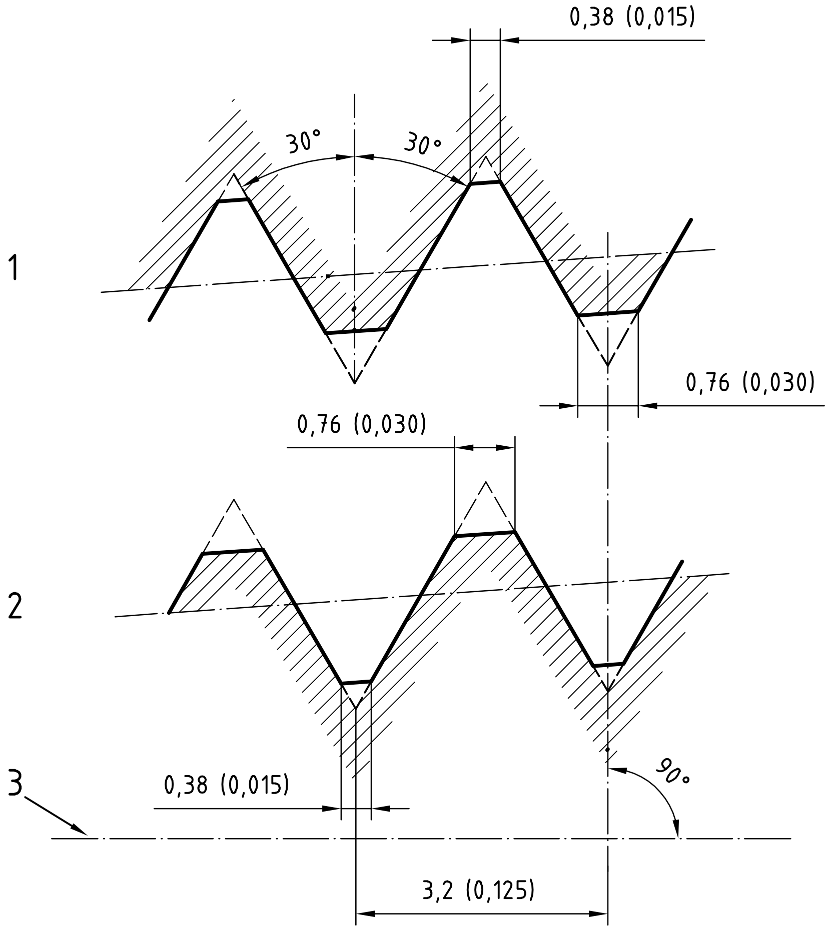
3 crosshead extension

4 piston rod

a 3,175 mm thread pitch (8 threads per inch) and 166,7 mm/m (2 in/ft) taper on pitch cone diameter.

Figure 15 — Crosshead, crosshead extension, and piston rod connections — Tapered thread type
(see Table 10 for dimensions)

Dimensions in millimetres (inches)



Key

1 internal thread

2 external thread

3 thread axis

Figure 16 — Tapered thread form (see 9.11.3.2 for description)

9.11.4.2 Thread dimensions and tolerances

Straight-thread type connections shall conform to the dimensions and tolerances given in Table 11, Figure 18 and Figure 19, and ANSI B1.1, and shall be gauged in accordance with ANSI B1.2. The following requirements are also applicable.

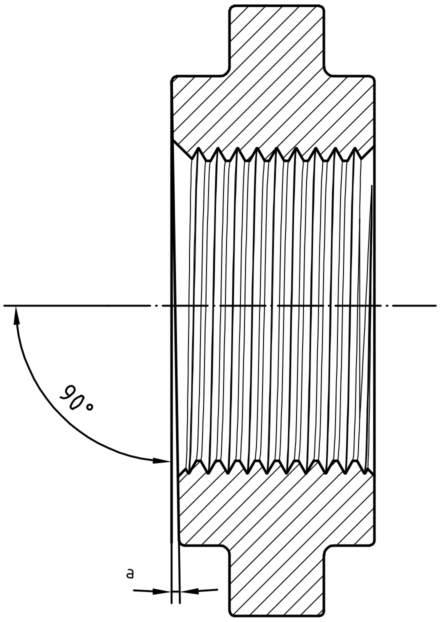
a) **Concentricity**: threads shall be concentric with rod design axis. Angular misalignment of thread axis with rod design axis shall not exceed 0,5 mm/m (0,000 5 in/in) of length.

b) **Length** (see Table 11):

1) Internal: $B = 1{,}25 \times A$ (10)

2) External: $C = B + D + 6{,}4$ mm (11)

c) **Perpendicularity**: face of internal thread member shall be perpendicular to thread axis within 1 mm/m (0,001 in/in) of face diameter.



[a] Contact face shall be perpendicular to thread axis with a tolerance of ± 0,001 mm/mm (in/in) of face diameter.

Figure 17 — Crosshead extension and piston rod locknut

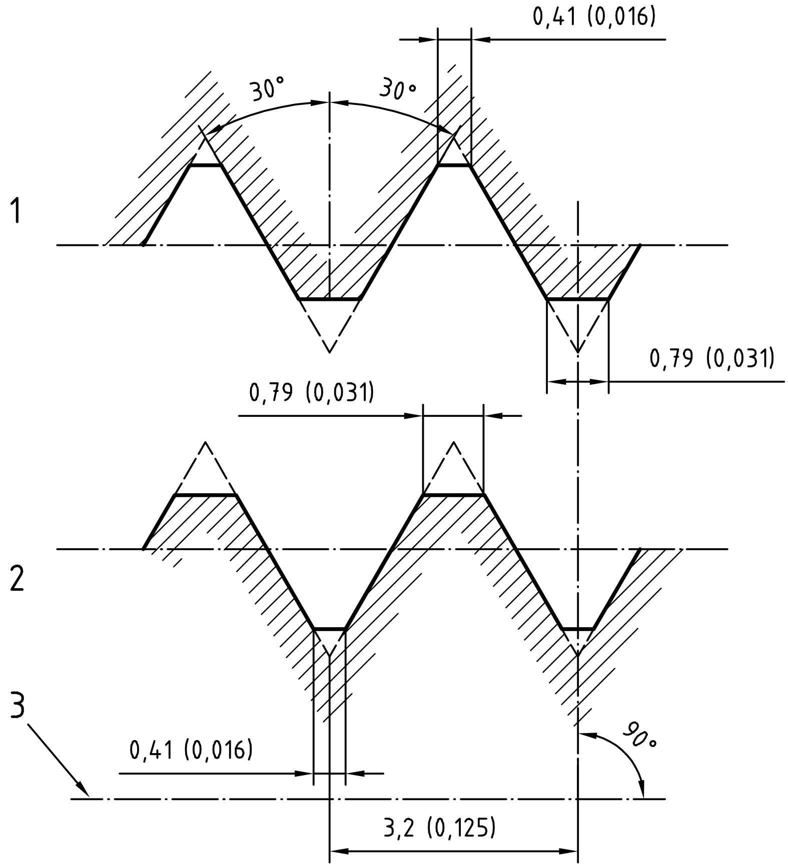
Table 11 — Crosshead, crosshead extension, and piston rod connections — Straight thread type
(see Figure 19 for illustration of dimension symbols)

Dimensions in millimetres (inches)

Straight thread number	Nominal size *A*[a]		Length of internal thread *B*		Length of external thread *C*		Locknut thickness minimum *D*	
S1	25,4	(1)	31,8	(1 1/4)	57,2	(2 1/4)	19,1	(3/4)
S2	28,6	(1 1/8)	35,7	(1 13/32)	61,1	(2 13/32)	19,1	(3/4)
S3	31,8	(1 1/4)	39,7	(1 9/16)	65,1	(2 9/16)	22,2	(7/8)
S4	34,9	(1 3/8)	43,7	(1 23/32)	69,1	(2 23/32)	22,2	(7/8)
S5	38,1	(1 1/2)	47,6	(1 7/8)	79,4	(3 1/8)	25,4	(1)
S6	41,3	(1 5/8)	51,6	(2 1/32)	83,3	(3 9/32)	25,4	(1)
S7	44,5	(1 3/4)	55,6	(2 3/16)	87,3	(3 7/16)	28,6	(1 1/8)
S8	47,6	(1 7/8)	59,5	(2 11/32)	91,3	(3 19/32)	28,6	(1 1/8)
S9	50,8	(2)	63,5	(2 1/2)	101,6	(4)	31,8	(1 1/4)
S10	57,2	(2 1/4)	71,4	(2 13/16)	109,5	(4 5/16)	34,9	(1 3/8)
S11	63,5	(2 1/2)	79,4	(3 1/8)	123,8	(4 7/8)	38,1	(1 1/2)
S12	69,9	(2 3/4)	87,3	(3 7/16)	131,8	(5 3/16)	41,3	(1 5/8)
S13	76,2	(3)	95,3	(3 3/4)	146,1	(5 3/4)	44,5	(1 3/4)
S14	82,6	(3 1/4)	103,2	(4 1/16)	154,0	(6 1/16)	47,6	(1 7/8)
S15	88,9	(3 1/2)	111,1	(4 3/8)	168,3	(6 5/8)	50,8	(2)
S16	101,6	(4)	127,0	(5)	184,2	(7 1/4)	50,8	(2)
S17	114,3	(4 1/2)	142,9	(5 5/8)	200,0	(7 7/8)	50,8	(2)
S18	127,0	(5)	158,8	(6 1/4)	215,9	(8 1/2)	50,8	(2)
S19	139,7	(5 1/2)	174,6	(6 7/8)	231,8	(9 1/8)	50,8	(2)
S20	152,4	(6)	190,5	(7 1/2)	247,7	(9 3/4)	50,8	(2)

[a] All threads are 8TPI, Series UN, Class 2A-2B modified.

Dimension in millimetres (inches)



Key

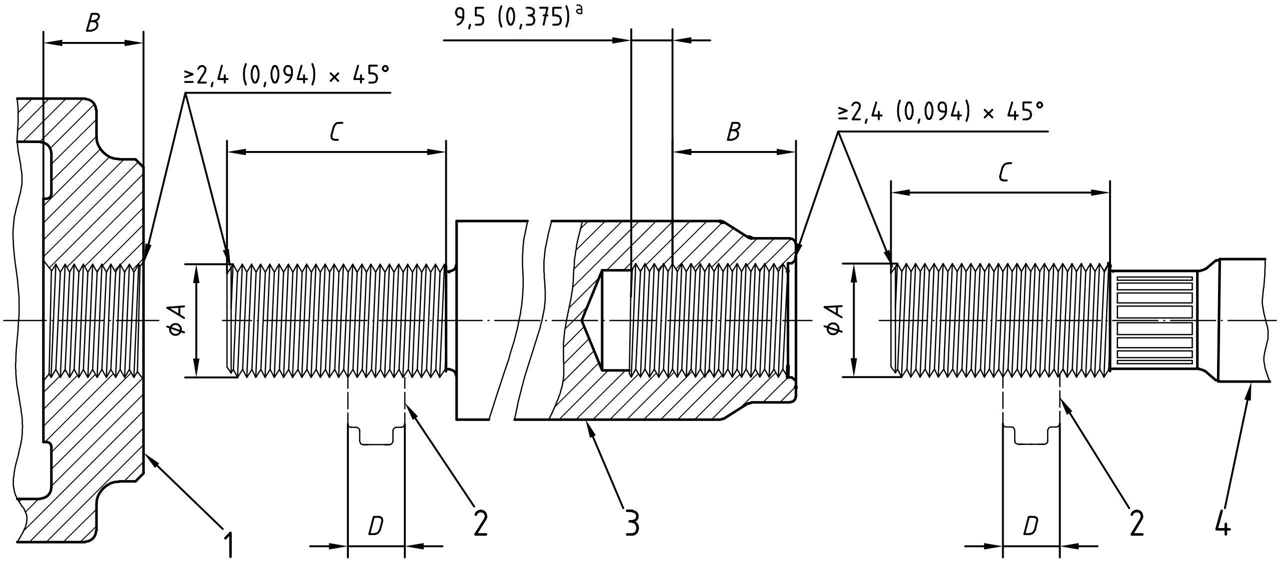
1 internal thread

2 external thread

3 thread axis

Figure 18 — Straight thread form (see 9.11.4.2 for description)

Dimensions in millimetres (inches)



Key

1 crosshead

2 locknut

3 crosshead extension

4 piston rod

a Imperfect thread.

Figure 19 — Crosshead, crosshead extension, and piston rod connections — Straight thread type
(see Table 11 for dimensions)

9.11.4.3 Locknuts

Crosshead extension and piston rod locknuts shall be furnished in accordance with Figure 19.

9.11.4.4 Taper threads

Locknut threads for the taper type connection shall conform to the requirements of 9.11.3.2.

9.11.4.5 Threads

Locknut threads for the straight type connection shall conform to the requirements of 9.11.4.2.

9.11.5 Mud-pump valve pots

9.11.5.1 Sizes and dimensions

Mud-pump valve pots shall be furnished in the sizes and dimensions given in Table 12 and Figure 20, or as specified on the purchase order. API valve pots for caged valves shall provide a minimum *G* dimension. See Table 12 for cage clearance.

9.11.5.2 Spring mounting dimensions

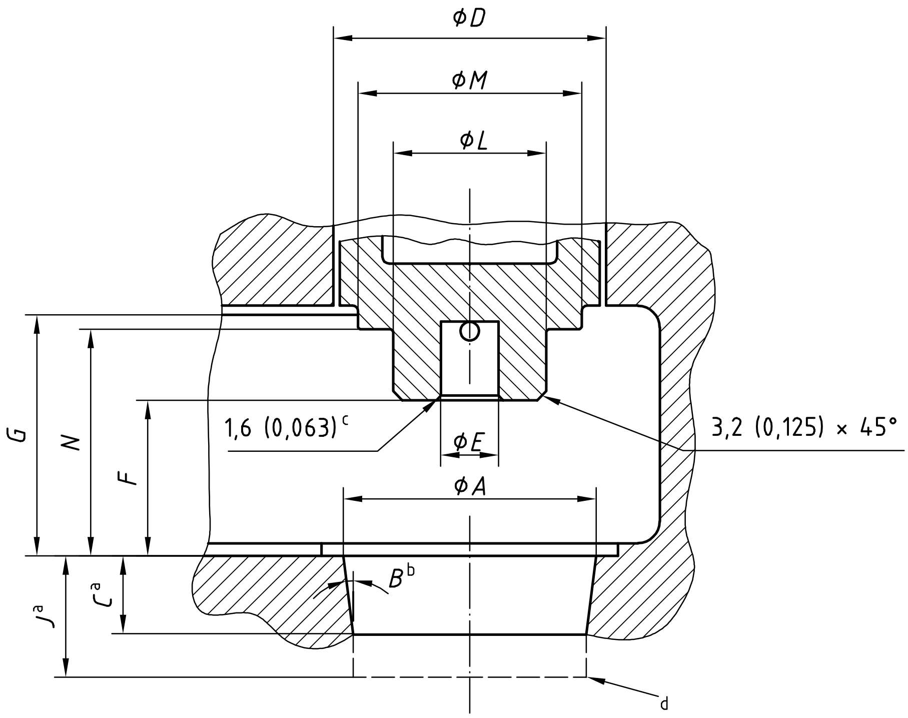
Valve-pot spring mounting dimensions shall conform to dimensions *L*, *M* and *N* in Figure 20 and Table 12.

Table 12 — Mud-pump valve pots (see Figure 20 for illustration of dimension symbols)
(see Table C.4 for US Customary units)

Dimensions in millimetres

Pot size	Valve pot dimensions								Spring mounting dimensions		
	A	*B*/m	*C*	*D*	*E*	*F*	*G*	*J*	*L*	*M*	*N*
1	73,0	166,7	25,4	82,6	Solid	44,5	Solid	57,2	25,4	63,5	63,5
2	85,7	166,7	28,6	95,3	20,6	57,2	85,7	63,5	44,5	76,2	82,6
3	98,4	166,7	31,8	108,0	20,6	63,5	95,3	66,7	44,5	76,2	88,9
4	111,1	166,7	34,9	120,7	20,6	69,9	104,8	69,9	50,8	76,2	95,3
5	127,0	166,7	38,1	136,5	33,3	76,2	123,8	79,4	69,9	95,3	108,0
5,5	136,5	166,7	41,3	146,1	33,3	82,6	133,4	85,7	69,9	95,3	114,3
6	142,9	166,7	44,5	152,4	33,3	82,6	133,4	85,7	69,9	95,3	114,3
7	158,8	166,7	50,8	168,3	33,3	88,9	142,9	95,3	69,9	95,3	120,7
8	177,8	166,7	57,2	187,3	33,3	95,3	152,4	98,4	69,9	95,3	127,0
9	196,9	166,7	63,5	206,4	33,3	101,6	161,9	104,8	69,9	95,3	133,4
10	215,9	166,7	73,0	225,4	33,3	108,0	171,5	123,8	69,9	95,3	139,7
11	241,3	166,7	82,6	250,8	33,3	114,3	181,0	136,5	69,9	95,3	146,1

Dimension in millimetres (inches)



a Minimum dimension

b Taper, mm/m (in/ft) on diameter

c Maximum chamfer

d Minimum clearance

Figure 20 — Mud-pump valve pot (see Table 12 for dimensions)

9.11.5.3 Marking

Mud-pump valve pots furnished in accordance with this International Standard shall be marked with the manufacturer's name or mark, with "ISO 14693", and the valve pot size number. Markings shall be cast or die stamped on the fluid cylinder or applied to a plate securely affixed to the fluid cylinder. Markings shall be applied in a location visible after installation of the fluid cylinder on the pump and may be applied to either pot. For pumps having divided fluid ends, each section shall be marked.

9.11.6 Mud-pump pistons

9.11.6.1 Sizes and dimensions

Mud-pump pistons shall be bored to fit standard taper of piston rods as given in Figure 12, Figure 13 and Table 8. Piston outside diameters shall be suitable for use in liners or cylinders having increments of diameter change as noted in 9.11.7.1 and Figure 21.

9.11.6.2 Marking

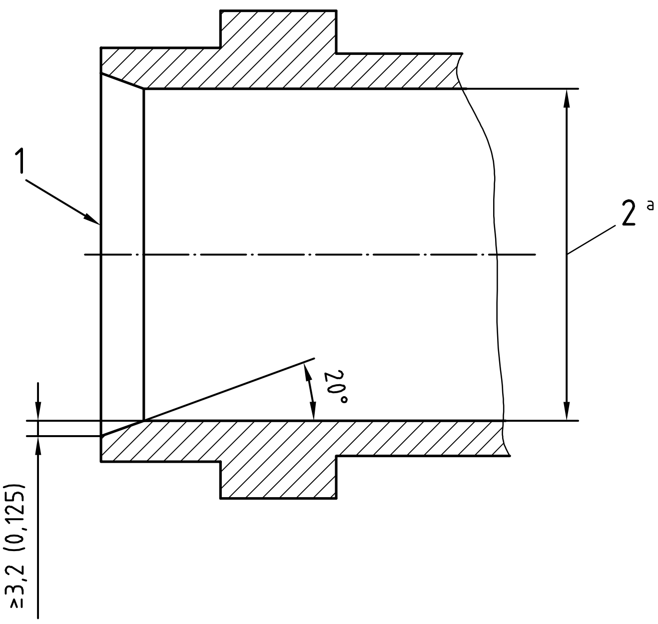
Pistons conforming to this International Standard shall be marked with the manufacturer's name or mark, the number of this International Standard (ISO 14693), the corresponding API rod number, and standard bore. Markings shall be stamped in letters 3,2 mm (1/8 in) high on the end face of piston core at the large end of the piston-rod hole.

9.11.7 Mud-pump liners

9.11.7.1 Liner bores

Bores of mud-pump liners 152,4 mm (6 in) in diameter and larger shall be supplied in 6,35 mm (1/4 in) increments. Bores smaller than 152,4 mm (6 in) in diameter shall be supplied in 12,7 mm (1/2 in) increments. Bore tolerances shall be as noted in Figure 21 or as specified on the purchase order.

Dimensions in millimetres (inches)



Key

1 piston entering end

2 liner bore

a Nominal diameter tolerance: $^{+0,130}_{0}$ mm $\left(^{+0,005}_{0} \text{ in}\right)$.

Figure 21 — Mud-pump liner

9.11.7.2 Chamfer

The inside edge of the piston entering end of mud-pump liners shall be chamfered as shown in Figure 21.

9.11.7.3 Marking

Mud-pump liners conforming to this International Standard shall be marked with the manufacturer's name or mark, the number of this International Standard (ISO 14693), and the size (standard bore) of the liner. Markings shall be stamped in letters 3,2 mm (1/8 in) high on the outer end of the liner.

9.11.8 Mud-pump gear ratings

9.11.8.1 Provisions

Ratings are based on surface durability (which is independent of pitch). However, the gear manufacturer shall assume responsibility for selecting a pitch sufficiently coarse to provide adequate tooth strength.

9.11.8.2 Design

Gears shall be single reduction, either helical or herringbone. Gear materials shall be in accordance with ANSI/AGMA Std 2004-B89. Gear strength and durability shall be determined in accordance with a national standard or code. Any practical combination of tooth height, pressure angle or helix angle may be used. However, American Gear Manufacturers Association standards are recommended. The mud-pump manufacturer shall be responsible for adequate shafting and support to maintain proper alignment under load.

9.11.8.3 Name-plate rating

The name-plate (power) rating of a mud pump shall not exceed the (power) rating of the gears.

9.11.9 Gauges and gauging practice for mud-pump components

9.11.9.1 General

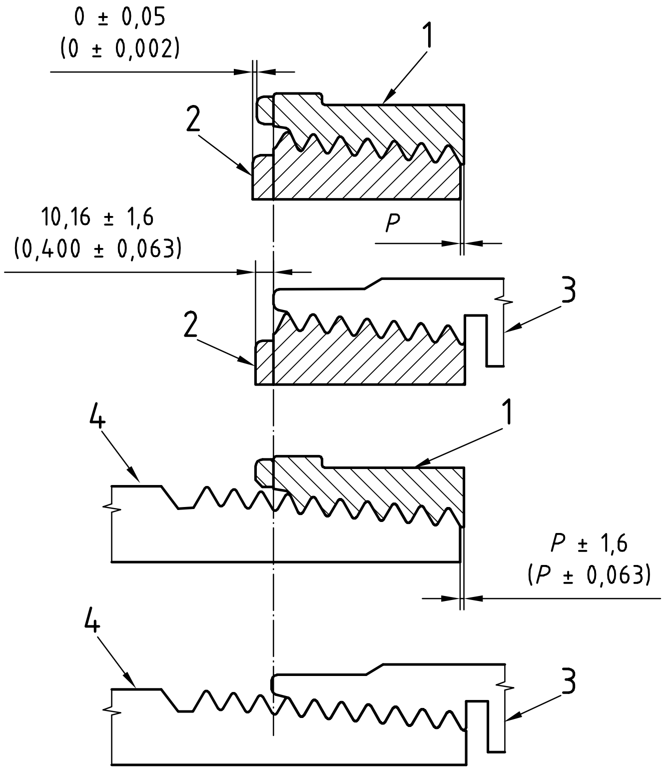
The gauges for the straight portion of tapered thread crosshead, crosshead extension, and piston rod connection, should not be used for the straight thread crosshead, crosshead extension and piston rod connections, because of the difference in length of engagement. Longer gauges are required for the straight thread connections.

9.11.9.2 Working gauges

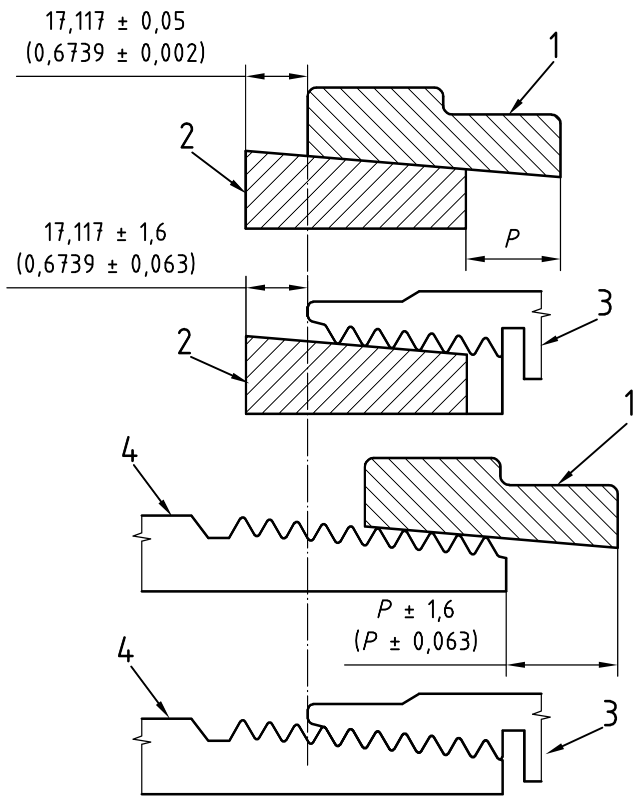
The manufacturer shall provide working gauges for use in gauging product threads, and shall maintain all working gauges in such condition as to ensure that product threads, gauged as specified herein, are acceptable under this International Standard. See Appendix C in API Specification 7 for recommended practice for care and use of working gauges. Working gauges shall be of such accuracy and construction as to ensure that the product threads conform to the requirements specified herein. The relationship between working gauges and product threads shall be as shown in Figure 22.

The mating standoffs, S, of the plain and threaded tapered ring gauges from the plug gauges are intended primarily as the basis for establishing the limits of wear or secular change in the gauges. Deviations from the initial S values should be taken into account in establishing working-gauge standoff values.

Dimension in millimetres (inches)



a) **Tapered thread gauges**



Key

1 ring gauge
2 plug gauge
3 product box
4 product pin

b) **Tapered plain gauges**

P extension of ring beyond end of product pin/plug gauge at full engagement

Figure 22 — Gauging practice for crosshead, crosshead extension, and piston rod connections — Tapered thread type (see 9.11.9.2 for descriptions)

9.11.9.3 Lead

The lead of thread plug and ring gauges shall be measured parallel to the thread axis along the pitch line, over the full threaded length, omitting one full thread at each end. The lead error between any two threads shall not exceed the tolerances specified in Table 13 except that, in the case of setting plugs, the tolerance applies to a length of thread equal to that in the mating ring gauge.

9.11.9.4 Taper

The included taper of tapered thread gauges shall be measured on the diameter along the pitch line over the full threaded length, omitting approximately one full thread at each end. The taper determined as above, and computed to the length L_{RT} (Table 14) shall conform to the basic taper within the tolerances specified in Table 13. The included taper of plain tapered plug and ring gauges shall be measured on the diameter over the full length, omitting approximately 1,6 mm (1/16 in) of length at each end. The taper as determined above, and computed to the length L_{RP} (Table 14), shall conform to the basic taper within the tolerance specified in Table 13. The taper of straight thread setting plugs shall not exceed 0,003 8 mm (0,000 15 in) over the length, L_{TS} (Table 15 and Figure 24). The permissible taper shall be back taper (largest diameter at the entering end) and shall be confined within the pitch diameter limits.

Table 13 — Tolerances on gauge dimensions

Dimensions in millimetres (inches) at 20 °C (67 °F), except as otherwise indicated

Tapered gauges (threaded and plain)							
Plug gauge				**Ring gauge**			
Pitch diameter at gauge point			± 0,010 (± 0,000 4)	Minor diameter at gauge point			± 0,051 (± 0,002)
Major diameter at gauge point			± 0,051 (± 0,002)	Outside diameter, D_R			± 0,381 (± 0,015)
Diameter of plain plug at large end, D_{EP}			± 0,010 (± 0,000 4)	Diameter of counterbore, D_R			± 0,381 (± 0,015)
Diameter of fitting plate, D_P			± 0,381 (± 0,015)	Diameter of fitting plate, D_P			± 0,381 (± 0,015)
Taper thread number	**Taper**[a] Threaded plug	**Taper**[a] Plain plug	**Lead**	**Taper thread number**	**Taper**[a] Threaded ring	**Taper**[a] Plain ring	**Lead**
T1 to T15	+ 0,010 (+ 0,000 4)	± 0,005 (± 0,000 2)	± 0,010 (± 0,000 4)	T1 to T15	− 0,010 (− 0,000 4)	± 0,005 (± 0,000 2)	± 0,015 (± 0,000 6)
T16 to T18	+ 0,013 (+ 0,000 5)	± 0,008 (± 0,000 3)	± 0,013 (± 0,000 5)		− 0,030 (− 0,001 2)		
T19 and T20	+ 0,018 (+ 0,000 7)	± 0,010 (± 0,000 4)	± 0,018 (± 0,000 7)	T16 to T18	− 0,013 (− 0,000 5)	± 0,008 (± 0,000 3)	± 0,020 (± 0,000 8)
Half-angle of thread			± 7 min		− 0,038 (− 0,001 5)		
Length, L_{PT} and L_{PP}			± 0,051 (± 0,002)	T19 and T20	− 0,018 (− 0,000 7)	± 0,010 (± 0,000 4)	± 0,025 (± 0,001 0)
					− 0,053 (− 0,002 1)		
				Half-angle of thread			± 15 min
				Length, L_{RT} and L_{RP}			± 0,051 (± 0,002)
				Mating standoff			± 0,051 (± 0,002)
Straight thread gauges							
Tolerances for straight thread plug and ring gauges to gauge the straight thread portion of the tapered type connection shall be as specified in ANSI B1.2 for class W gauges.							
The ends of plug and ring gauges shall be square with the thread axis within a tolerance of 0,025 mm (0,001 in).							
[a] Tolerances for taper apply to the full gauge length.							

Table 14 — Tapered thread and plain gauges[a] (see Figure 23 for illustration of dimension symbols)
(see Table C.5 for US customary units)

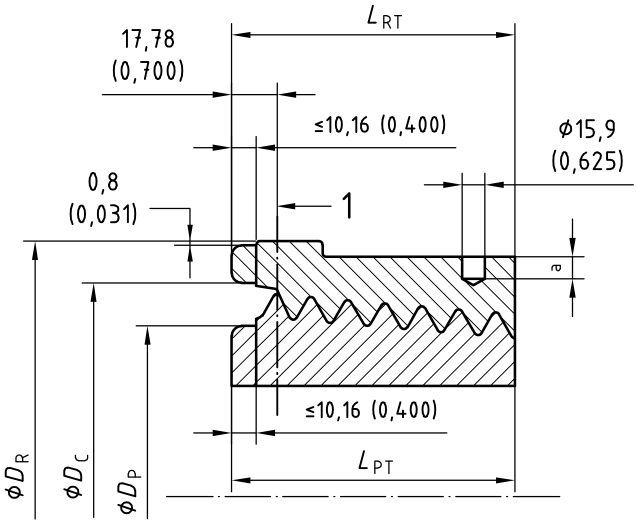
Dimensions in millimetres at 20 °C

Taper thread number	Nom. size	Outside diam. of ring	Tapered thread gauges[b]						Tapered plain gauges		
			Pitch diam. at gauge point	Major diam. at gauge point	Minor diam. at gauge point	Diam. of fitting plate	Length of plug & ring	Diam. of counter-bore	Diam. of plug at large end	Diam. of ring at large end	Length of plug & ring
		D_R				D_P	L_{PT} & L_{RT}	D_C	D_{EP}	D_{ER}	L_{PP} & L_{RP}
T1	1	60,3	21,930 4	23,356 8	20,503 9	17,27	41,910	29,11	24,626 8	21,773 9	31,750
T2	1 1/8	63,5	25,101 6	26,528 0	23,675 1	20,45	45,878	32,28	27,798 0	24,945 1	35,718
T3	1 1/4	66,7	28,275 3	29,701 7	26,848 8	23,62	49,848	35,46	30,971 8	28,118 8	39,688
T4	1 3/8	69,9	31,445 2	32,871 7	30,018 7	26,80	53,818	38,63	34,141 7	31,288 7	43,658
T5	1 1/2	73,0	34,618 9	36,045 4	33,192 5	29,97	57,785	41,81	37,315 4	34,462 5	47,625
T6	1 5/8	76,2	37,792 7	39,219 1	36,359 3	33,15	61,752	44,98	40,489 1	37,636 2	51,593
T7	1 3/4	79,4	40,963 8	42,390 3	39,537 4	36,32	65,723	48,16	43,660 3	40,807 4	55,563
T8	1 7/8	82,6	44,136 3	45,562 8	42,709 8	39,50	69,693	51,33	46,832 8	43,980 0	59,533
T9	2	85,7	47,31	48,736 5	45,883 6	42,67	73,660	54,51	50,006 5	47,153 6	63,500
T10	2 1/4	92,1	53,655 0	55,081 4	52,228 5	49,00	81,598	60,83	56,351 4	53,498 5	71,438
T11	2 1/2	98,4	60,002 4	61,428 9	58,576 0	55,35	89,535	67,18	62,698 9	59,846 0	79,375
T12	2 3/4	117,5	66,348 5	67,775 1	64,922 1	61,70	97,473	73,53	69,045 1	66,192 1	87,313
T13	3	123,8	72,693 5	74,120 0	71,267 1	68,05	105,410	79,88	75,389 9	72,537 1	92,250
T14	3 1/4	130,2	79,041 0	80,467 5	77,614 5	74,40	113,348	86,23	81,737 5	78,884 5	103,188
T15	3 1/2	136,5	85,389 7	86,816 2	83,963 3	80,75	121,285	92,58	88,086 2	85,233 3	111,125
T16	4	149,2	98,083 4	99,509 8	96,656 9	93,45	137,160	105,28	100,779 8	97,927 0	127,000
T17	4 1/2	161,9	110,777	112,203 5	109,350 6	106,12	153,035	117,96	113,473 5	110,620 6	142,875
T18	5	174,6	123,471	124,897 1	122,044 2	118,82	168,910	130,65	126,167 1	123,314 2	158,750
T19	5 1/2	187,3	136,166	137,592 1	134,739 1	131,52	184,785	143,36	138,862 0	136,009 1	174,625
T20	6	200,0	148,862	150,288 2	147,435 3	144,22	200,660	156,06	151,558 2	148,705 3	190,500

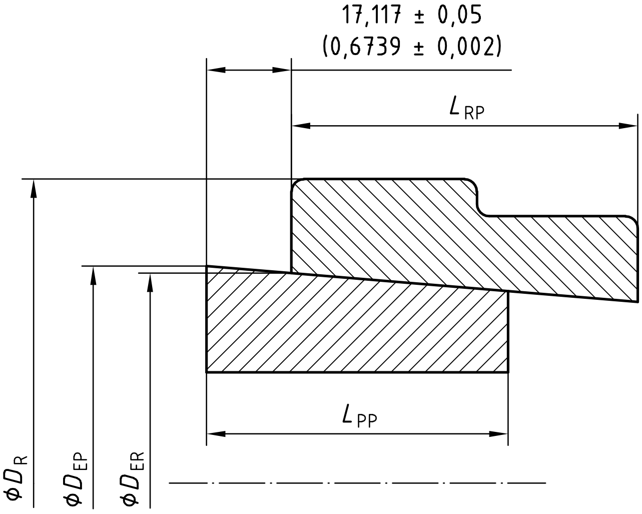
[a] Taper for all sizes is 166,67 mm/m on diameter.

[b] All threads are 8 TPI, pitch = 3,175 mm.

Dimension in millimetres (inches)



a) Tapered thread gauge



b) Tapered plain gauge

Key

1 plane of gauge point

a 9,5 mm to 19,1 mm (0,375 in to 0,75 in). Dimension varies with gauge size.

Figure 23 — Tapered-thread and plain gauges (see Table 14 for dimensions)

9.11.9.5 Fit

Go and no-go adjustable straight-thread ring gauges shall be set to snug-fit at full engagement on their mating plugs. An adjustable ring gauge shall be set initially on either the full form or the truncated portion of the setting plug. When screwed onto the other portion of the setting plug, there shall be only a slight change in fit, if any. If there is perceptible shake or play in the looser fit, the ring and, if necessary, the plug shall be reconditioned.

9.11.9.6 Root form

The roots of tapered-thread plug and ring gauges shall be approximately sharp with a radius not exceeding 0,25 mm (0,010 in), or undercut to a maximum width equivalent to the basic root truncation given in Table 17. The undercut shall be substantially symmetrical with respect to the adjoining thread flanks and of such depth as to clear the basic sharp thread; otherwise, the shape of the undercut shall be optional with the gauge manufacturer.

9.11.9.7 Thread roots

The thread roots of go thread plug and ring gauges, no-go thread plug and ring gauges, and setting thread plug gauges for the straight thread on the pin and the thread in the locknut shall be as specified in ANSI B1.2. See Tables 15, 16 and 17 and Figures 24, 25 and 26 for dimensional tolerances.

Table 15 — Pin go and no-go gauges[a] (for straight threaded portion of tapered thread connection)
(see Figure 24 for illustration of dimension symbols) (see Table C.6 for US customary units)

Dimensions in millimetres at 20 °C

Taper thread number	Nom. size	Full form major diam.	Go gauges					No-go gauges				
			Truncated major diam.	Pitch diam.	Thread length	Ring length	Ring minor diam.	Truncated major diam.	Pitch diam.	Thread length	Ring length	Ring minor diam.
		B_S	B_{ST}	E_S	L_{TS}	L_N	K_N	B_{ST}	E_S	L_{TS}	L_N	K_N
T1	1	24,717	24,282	23,287	53,975	23,8	21,857	23,828	23,114	38,1	17,5	22,400
T2	1 1/8	27,889	27,455	26,459	53,975	23,8	25,029	26,998	26,284	38,1	17,5	25,570
T3	1 1/4	31,064	30,630	29,634	60,325	28,6	28,204	30,170	29,456	41,3	19,1	28,743
T4	1 3/8	34,237	33,802	32,807	60,325	28,6	31,377	33,338	32,624	41,3	19,1	31,910
T5	1 1/2	37,411	36,977	35,982	60,325	28,6	34,552	36,510	35,796	41,3	19,1	35,082
T6	1 5/8	40,587	40,152	39,157	73,025	31,8	37,727	39,682	38,969	47,6	20,6	38,255
T7	1 3/4	43,759	43,325	42,329	73,025	31,8	40,900	42,852	42,139	47,6	20,6	41,425
T8	1 7/8	46,934	46,500	45,504	73,025	31,8	44,074	46,022	45,309	47,6	20,6	44,595
T9	2	50,109	49,675	48,679	73,025	31,8	47,249	49,195	48,481	47,6	20,6	47,767
T10	2 1/4	56,457	56,022	55,027	76,200	34,9	53,597	55,537	54,823	50,8	22,2	54,110
T11	2 1/2	62,807	62,372	61,377	82,550	38,1	59,947	61,882	61,168	50,8	22,2	60,455
T12	2 3/4	69,154	68,720	67,724	88,900	41,3	66,294	68,227	67,513	50,8	22,2	66,799
T13	3	75,502	75,067	74,071	95,250	44,5	72,641	74,569	73,856	50,8	22,2	73,142
T14	3 1/4	81,852	81,417	80,421	101,600	47,6	78,991	80,914	80,201	50,8	23,8	79,487
T15	3 1/2	88,202	87,767	86,771	107,950	50,8	85,341	87,262	86,548	50,8	23,8	85,834
T16	4	100,899	100,465	99,469	107,950	50,8	98,039	99,952	99,238	50,8	23,8	98,524
T17	4 1/2	113,596	113,162	112,166	107,950	50,8	110,736	112,641	111,928	54,0	25,4	111,214
T18	5	126,294	125,860	124,864	107,950	50,8	123,434	125,331	124,617	54,0	25,4	123,904
T19	5 1/2	138,991	138,557	137,561	107,950	50,8	136,131	138,024	137,310	54,0	25,4	136,596
T20	6	151,691	151,257	150,261	107,950	50,8	148,831	150,716	150,002	54,0	25,4	149,289

[a] All threads are 8 TPI, pitch = 3,175 mm.

Table 16 — Box go and no-go gauges[a] (for locknut) (see Figure 25 for illustration of dimension symbols) (see Table C.7 for US customary units)

Dimensions in millimetres at 20 °C

Taper thread number	Nominal size	Go gauges			No-go gauges		
		Major diam B_S	Pitch diam E_S	Thread length L_T	Major diam B_S	Pitch diam E_S	Thread length L_T
T1	1	24,768	23,338	25,4	24,275	23,561	15,9
T2	1 1/8	27,943	26,513	25,4	27,455	26,741	15,9
T3	1 1/4	31,118	29,688	31,8	30,635	29,921	19,1
T4	1 3/8	34,293	32,863	31,8	33,813	33,099	19,1
T5	1 1/2	37,468	36,038	31,8	36,993	36,279	19,1
T6	1 5/8	40,643	39,213	31,8	40,173	39,459	22,2
T7	1 3/4	43,818	42,388	31,8	43,350	42,636	22,2
T8	1 7/8	46,993	45,563	31,8	46,530	45,817	22,2
T9	2	50,168	48,738	31,8	49,708	48,994	22,2
T10	2 1/4	56,518	55,088	34,9	56,065	55,352	22,2
T11	2 1/2	62,868	61,438	50,8	62,421	61,707	22,2
T12	2 3/4	69,218	67,788	54,0	68,776	68,062	25,4
T13	3	75,568	74,138	54,0	75,133	74,420	25,4
T14	3 1/4	81,918	80,488	57,2	81,488	80,775	25,4
T15	3 1/2	88,268	86,838	57,2	87,843	87,130	25,4
T16	4	100,968	99,538	57,2	100,554	99,840	25,4
T17	4 1/2	113,668	112,238	57,2	113,261	112,547	25,4
T18	5	126,368	124,938	57,2	125,971	125,258	25,4
T19	5 1/2	139,068	137,638	57,2	138,679	137,965	25,4
T20	6	151,768	150,338	57,2	151,387	150,673	25,4

[a] All threads are 8 TPI, pitch = 3,175 mm.

Table 17 — Gauge thread height dimensions (see Figure 26 for illustration of dimension symbols)

Dimensions in millimetres (inches) at 20 °C (68 °F)

Thread element	Tapered[a, b] thread gauges	Straight[c] thread gauges
$f_{rn}, f_{cn}, f_{rs}, f_{cs}$	0,658 4 (0,025 92)	0,659 9 (0,025 98)
h_g	1,426 5 (0,056 16)	1,429 8 (0,056 29)
H	2,743 2 (0,108 00)	2,749 6 (0,108 25)

[a] The effect of taper has been taken into account in computing thread height and truncation.

[b] Taper = 166,67 mm/m (2,000 in/ft) on diameter, pitch = 3,175 mm (0,125 0 in).

[c] Pitch = 3,175 mm (0,125 0 in).

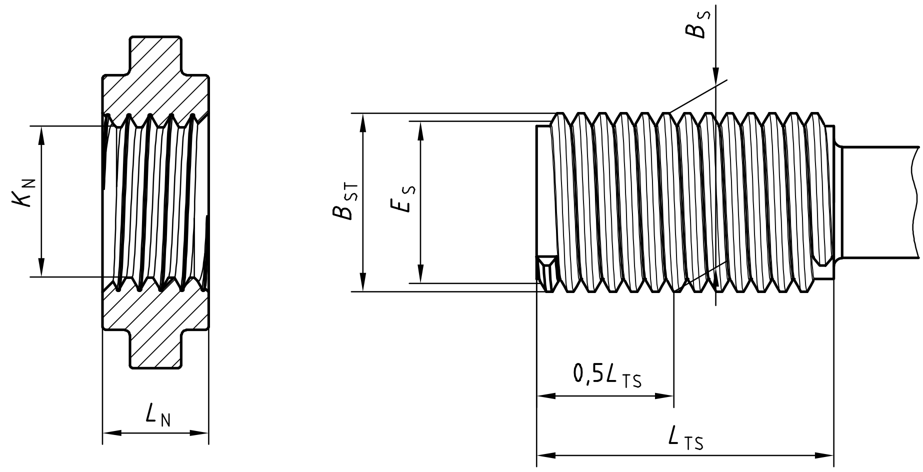


Figure 24 — Pin go and no-go gauges (for straight-threaded portion of tapered-thread connection) (see Table 15 for dimensions)

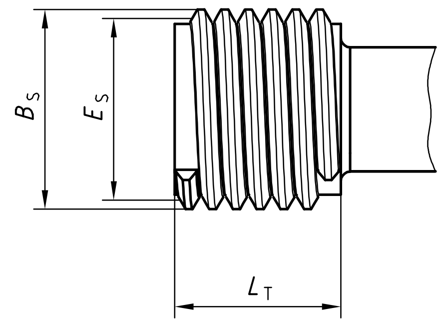
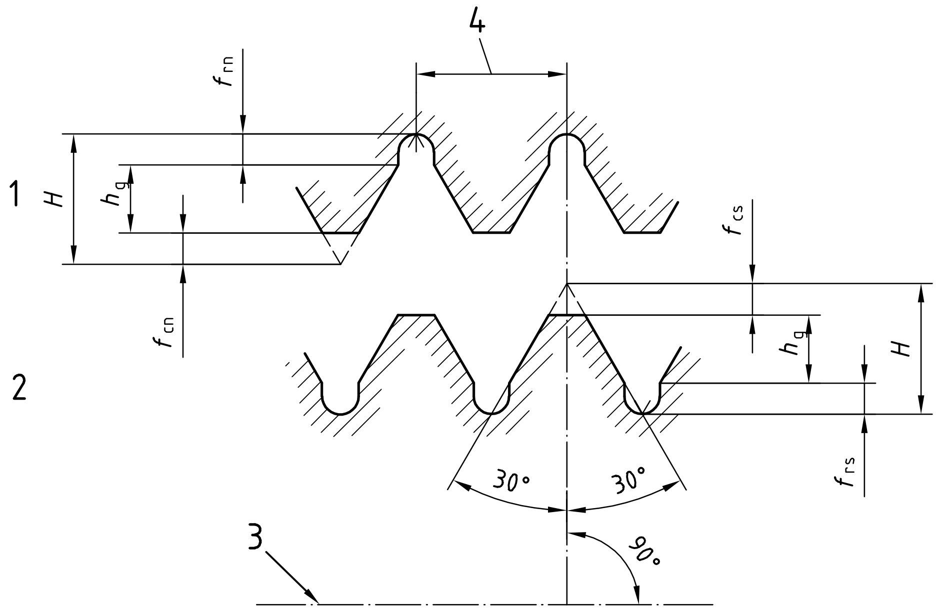


Figure 25 — Box go and no-go gauges (for locknut) (see Table 16 for dimensions)



Key

1 internal thread

2 external thread

3 thread axis

4 pitch

Figure 26 — Gauge thread form (see Table 17 for dimensions)

9.11.9.8 Pitch diameter

In computing pitch diameter, the effect of helix angle shall be disregarded.

9.11.9.9 Initial standoff

The large ends of tapered-thread gauges shall be flush within ± 0,05 mm (± 0,002 in). The standoff of plain tapered gauges shall be 17,117 ± 0,05 mm (0,673 9 ± 0,002 in).

9.11.9.10 Determination of standoff

Mating standoff (as illustrated in Figure 22 and Figure 23) shall be determined as follows.

a) During the test all pieces entering into the measurement shall be at a uniform temperature near 20 °C (68 °F).

b) Gauges shall be benzene-cleaned before mating. Gauges shall be made up within a thin film of white mineral oil of grade and viscosity such as Nujol[8], Squibb's liquid petrolatum[3] or equivalent, wiped onto threads with a clean chamois skin or bristle brush.

8) Nujol and Squibb's liquid petrolatum are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

c) The pair shall be mated hand-tight without spinning into place, and complete register shall be accomplished with the torque hammer as shown in Figure 27 using the following weights:

— for gauges T1 to T9, use a 0,45 kg (1 lb) weight;

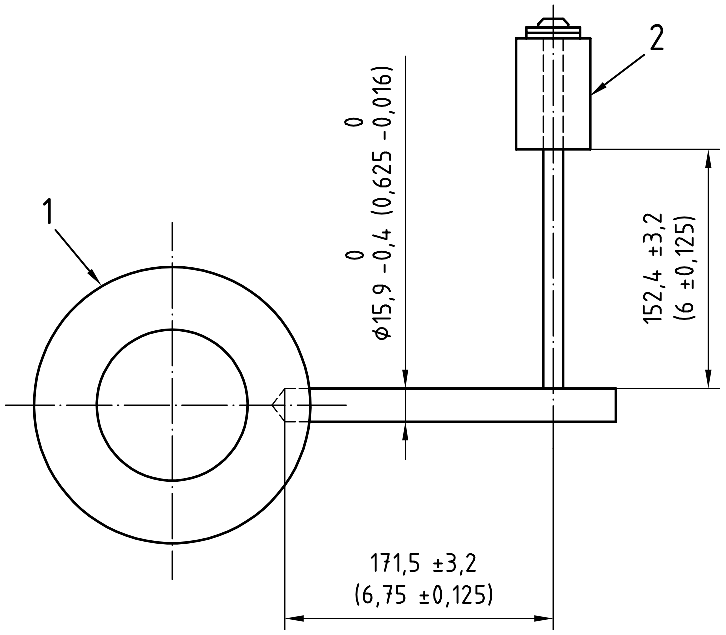
— for gauges T10 to T13, use a 0,91 kg (2 lbs) weight;

— for gauges T14 to T17, use a 1,36 kg (3 lbs) weight;

— for gauges T18 to T20, use a 1,81 kg (4 lbs) weight.

d) The number of torque hammer blows is unimportant. Sufficient number should be made so that continued hammering will not move the ring relative to plug. When testing, the plug gauge should be rigidly held, preferably in a vice mounted on a rigid workbench. When so held, 12 torque hammer blows should be sufficient to make complete register.

Dimensions in millimetres (inches)



Key

1 gauge

2 weight

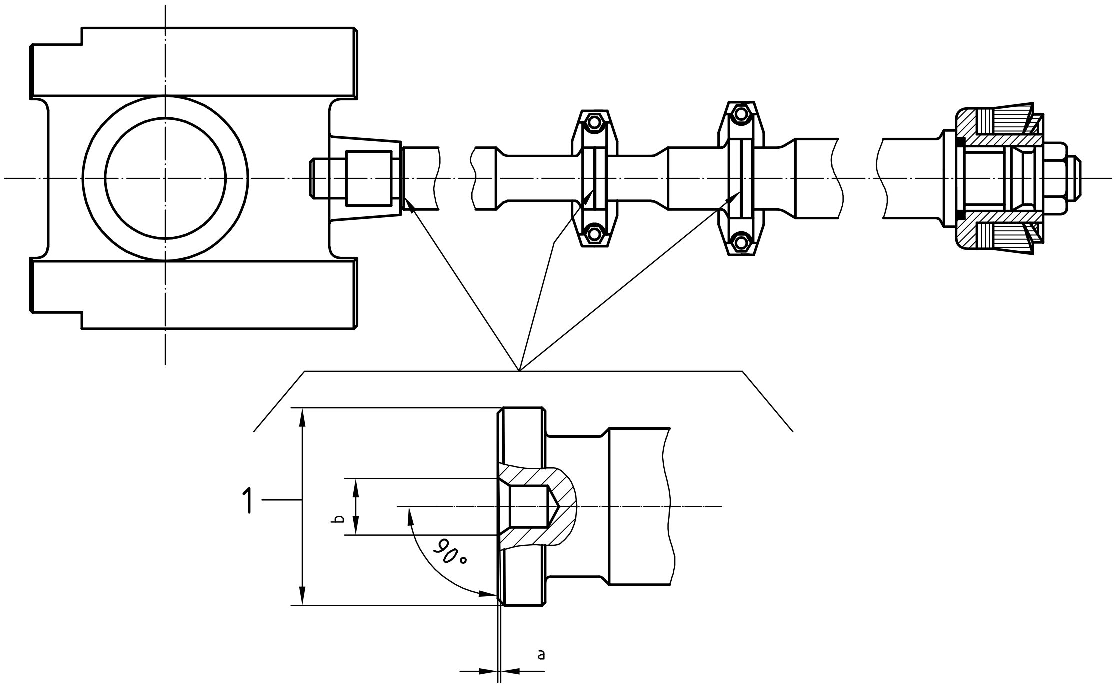
Figure 27 — Torque hammer

9.11.9.11 Maintenance of gauges

The maintenance of gauges within the specified limits shall be the responsibility of the gauge user. Tapered-thread gauges shall be tested for standoff by the procedures listed herein, the interval between tests being dependent on use. A pair of tapered gauges may be considered safe for continued use provided the mating standoff does not differ from the original standoff by more than 0,13 mm (0,005 in).

9.11.10 Triplex mud-pump crosshead, crosshead extension, and piston rod connection — Contacting flat faces and pilot diameters

On triplex mud pumps, all rod connections between the crosshead and piston hub that affect rod alignment shall have tolerances that do not exceed those shown in Figure 28.



Key

1 face diameter

a Contacting flat faces or mating rod connections, and crosshead extension shall be perpendicular to centreline of rod with a tolerance of 0,0005 m/m (0,0005 in/in) of face diameter.

b Concentricity tolerance between pilot diameter's centreline and theoretical centreline of rod shall not exceed 0,13 mm (0,005 in).

Figure 28 — Contacting flat faces and pilot diameters on mating connections from crosshead extension to piston hub on mud pumps

9.12 Antifriction bearings

Antifriction bearings used as primary load path components shall be designed and manufactured in accordance with a recognized bearing-industry code or standard. Antifriction bearings shall be exempt from the requirements of Clause 4 through Clause 8 of this International Standard.

10 Marking

10.1 Product marking

Each item of equipment shall be marked with the number of this International Standard (ISO 14693) and the manufacturer's name or mark. Additional markings shall be applied in accordance with Clause 9. Equipment for which supplementary requirements apply shall be marked with the relevant “SR” numbers.

10.2 Marking method

Marking shall be applied using low-stress, hard-die stamps, or shall be cast into components. It shall be clearly visible, clearly legible and at least 9,5 mm (3/8 in) high where the physical dimensions of the component will permit.

11 Documentation

11.1 Record retention

Full records of any documentation required in this International Standard shall be kept by the manufacturer for a period of ten years after the equipment has been manufactured and sold. Documentation shall be clear, legible, reproducible, retrievable, and protected from damage, deterioration, or loss.

All quality control records required by this International Standard shall be signed and dated. Computer-sorted records shall contain the originator's personal code.

When requested by a purchaser of the equipment, authorities or certifying agencies, the manufacturer shall make available all records and documentation for examination to demonstrate compliance with this International Standard.

11.2 Documentation to be kept by the manufacturer

The following documentation shall be kept by the manufacturer:

a) design documentation (see 4.9);

b) design verification documentation (see Clause 5);

c) written specifications (see Clause 6 through Clause 8);

d) qualification records, such as

- weld procedure qualification records,
- welder qualification records,
- NDE personnel qualification records,
- measuring and test equipment calibration records.

e) inspection and test records traceable to the equipment or components, including

- material test reports covering the following tests, as applicable: chemical analysis, tensile tests, impact tests, and hardness tests,
- NDE records covering the surface and/or volumetric NDE requirements of Clause 8,
- performance test records, including proof load-testing records, hydrostatic pressure-testing records, and functional-testing records,
- special process records.

Special process records include actual heat-treatment time/temperature charts and weld-repair records as described in Clause 7. These records shall be traceable to the applicable components and shall be maintained by the manufacturer, or by the party carrying out the special process if the work is subcontracted. In the latter case, the requirements of 11.1 shall equally apply to the subcontractor.

11.3 Documentation to be delivered with the equipment

The following documentation shall be delivered with the equipment:

a) the manufacturer's statement of compliance attesting to full compliance with the requirements of this International Standard and any other requirements stipulated by the purchase order. The statement shall identify any noted deviations from the specified requirements;

b) proof load test record (as applicable);

c) Operations/maintenance manuals, which shall include but not be limited to

- assembly drawings,
- list of components,
- nominal capacities and ratings,
- operating procedures,
- wear limits,
- recommended frequency of field inspection and preventive maintenance, methods and acceptance criteria,
- itemized spare parts (not applicable to single component equipment) and recommended stock levels.

A comprehensive data book can be specified by the purchaser by calling out supplementary requirement SR3 (see Annex A) in the purchase order.

Annex A
(normative)

Supplementary requirements

A.1 Introduction

If specified in the purchase order, one or more of the following supplementary requirements shall apply.

A.2 SR1 — Proof load testing

The equipment shall be proof load-tested and subsequently examined in accordance with the requirements of 8.6.

The equipment shall be marked “SR1” by means of low-stress hard-die stamping near the load rating identification.

A.3 SR2 — Low-temperature testing

The maximum impact-test temperature, for materials used in primary load-carrying components of covered equipment with a required minimum operating temperature below that specified in 4.1, shall be specified by the purchaser.

Impact testing shall be performed in accordance with the requirements of 6.3.1 and ISO 148 or ASTM A 370. Except for manual tong hinge pins of wrought material, the minimum average Charpy impact energy of three full-size test pieces tested at the specified (or lower) temperature shall be 27 J (20 ft-lb), with no individual value less than 20 J (15 ft-lb). For manual tong hinge pins of wrought material, the minimum average impact energy of three full-size Charpy impact test pieces, tested at the specified (or lower) temperature, shall be 15 J (11 ft-lb) with no individual value less than 12 J (8,5 ft-lb).

Each primary load-bearing component shall be marked “SR2” to indicate that low-temperature testing has been performed. Each primary load-bearing component shall also be marked to indicate the actual design and test temperature in degrees Celsius.

A.4 SR2A — Additional low-temperature testing

Impact testing shall also be applicable to materials used in the primary load-carrying components of equipment normally exempted from impact testing. The components to which impact testing shall apply shall be determined by mutual agreement of the purchaser and the manufacturer.

Impact testing shall be performed in accordance with the requirements of 6.3.1 and ISO 148 or ASTM A 370. The maximum impact test temperature and the minimum average and individual values shall be as agreed upon by the purchaser and the manufacturer.

Each covered primary load-carrying component shall be marked “SR2A” to indicate that additional low temperature testing has been performed. The component shall also be marked with the temperature in degrees Celsius to indicate the actual design and test temperature.

A.5 SR3 — Data book

When requested by the purchaser, records shall be prepared, gathered, and properly collated in a data book by the manufacturer. The data book shall include for each unit at least the following information:

a) statement of compliance;

b) equipment designation/serial number;

c) assembly and critical area drawings;

d) wear limits and nominal capacities and ratings;

e) list of components;

f) traceability codes and systems (marking on parts/records on file);

g) steel grades;

h) heat-treatment records;

i) material test reports;

j) NDE records;

k) performance test records, including functional hydrostatic and load test certificates (when applicable);

l) certificates for supplementary requirements, as required;

m) welding procedure specifications and qualification records.

A.6 SR4 — Additional volumetric examination of castings

The requirements for SR4 shall be identical to the requirements for 8.4.8, except that all critical areas of each primary load-carrying casting shall be examined.

A.7 SR5 — Volumetric examination of wrought material

The entire volume of primary load-carrying wrought components shall be examined by the ultrasonic method. When examination of the entire volume is impossible due to geometric factors, such as radii at section changes, the maximum practical volume shall suffice.

Ultrasonic examination shall be in accordance with ASTM A 388 (the immersion method may be used) and ASTM E 428. Straight-beam calibration shall be performed using a distance vs. amplitude curve based on a flat-bottomed hole with a diameter of 3,2 mm (1/8 in) or smaller.

Wrought components examined by the ultrasonic method shall meet the following acceptance criteria.

a) For both straight and angle beam examination, any discontinuity resulting in an indication which exceeds the calibration reference line is not allowed. Any indication interpreted as a crack or thermal rupture is also not allowed.

b) Multiple indications (i.e. two or more indications), each exceeding 50 % of the reference distance vs. amplitude curve and located within 13 mm (1/2 in) of one another, are not allowed.

Annex B
(informative)

Guidance for qualification of heat-treatment equipment

B.1 Temperature tolerance

The temperature at any point in the working zone shall not vary by more than ± 14 °C from the furnace set-point temperature after the furnace working zone has been brought up to temperature. Furnaces used for tempering, ageing and/or PWHT shall not vary by more than ± 14 °C from the furnace set-point temperature after the furnace working zone has been brought up to temperature.

B.2 Furnace calibration

B.2.1 General

Heat-treating of production parts shall be performed with heat-treating equipment that has been calibrated and surveyed.

B.2.2 Records

Records of furnace calibration and surveys shall be maintained for a period of not less than two years.

B.2.3 Batch-type furnace methods

Batch-type furnace methods include the following.

a) A temperature survey within the furnace working zone(s) shall be performed on each furnace at the maximum and minimum temperatures for which each furnace is to be used.

b) A minimum of nine thermocouple test locations shall be used for furnaces having a working zone volume greater than 0,29 m^3 (10 ft^3). For rectangular furnaces, place one thermocouple in each of the eight corners of the furnace. The ninth shall be placed near the centre of the furnace. For cylindrical furnaces, the nine thermocouple test locations shall be placed at three elevations and approximately 120° apart, as shown in Figure B.1.

c) For each 3,54 m^3 (125 ft^3) of furnace working zone volume surveyed, at least one thermocouple test location shall be used, up to a maximum of 60 thermocouples. These additional thermocouples shall be distributed within the working zone of the furnace.

d) For furnaces having a working zone volume less than 0,29 m^3 (10 ft^3), the temperature survey may be made with a minimum of three thermocouples located at the front, centre and rear or at the top, centre and bottom of the furnace working zone.

e) After insertion of the temperature-sensing devices, readings shall be taken at least once every 3 min to determine when the temperature of the furnace working zone approaches the bottom of the temperature range being surveyed.

f) Once the furnace has reached the set-point temperature, the temperature of all test locations shall be recorded at maximum intervals of 2 min, for at least 10 min. Then, readings shall be taken at maximum intervals of 5 min for sufficient time to determine the recurrent temperature pattern of the furnace working zone for at least 30 min.

g) Before the furnace set-point temperature is reached, none of the temperature readings shall exceed the set-point temperature by more than 14 °C.

h) After the furnace control set-point temperature is reached, no temperature readings shall exceed the limits specified. Each furnace shall be surveyed within one year prior to heat-treatment.

i) If a furnace is repaired or rebuilt, a new survey shall be performed before heat-treatment.

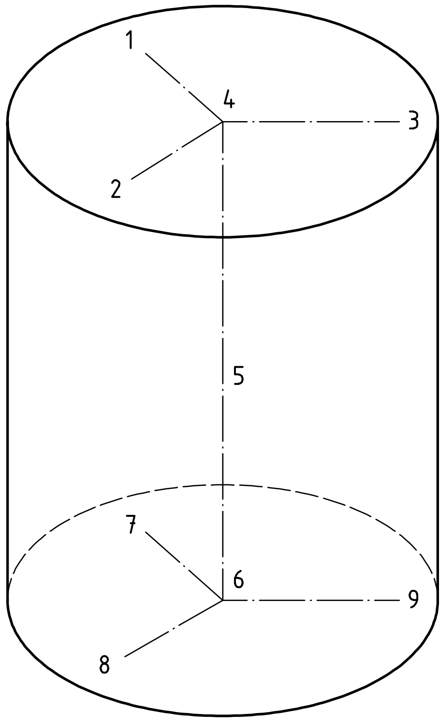


Figure B.1 — Thermocouple locations in cylindrical furnaces

B.2.4 Continuous-type furnace method

Continuous heat-treating furnaces shall be calibrated in accordance with procedures specified in MIL-H-6875F, Section 3.

B.3 Instruments

B.3.1 General

Automatic controlling and recording instruments shall be used. Thermocouples shall be located in the furnace working zone(s) and protected from furnace atmospheres by means of suitable protective devices.

B.3.2 Accuracy

The controlling and recording instruments used for the heat-treatment processes shall possess an accuracy of ± 1 % of their full-scale range.

B.3.3 Calibration

Temperature-controlling and -recording instruments shall be calibrated at least once every three months.

Equipment used to calibrate the production equipment shall possess an accuracy of ± 0,25 % of full scale.

Annex C
(informative)

Drilling machinery component dimensions expressed in US customary units

Tables C.1 to C.7 provide drilling machinery component dimensions in US customary units.

Table C.1 — Rotary vibrator and drilling hose dimensions and pressures
(see Figure 11 for illustration of dimension symbols)

Size inside diameter	**Thread or flange size**	**Working pressure** psi					**Test pressure** psi				
D in	*T* in	Grade A	Grade B	Grade C	Grade D	Grade E	Grade A	Grade B	Grade C	Grade D	Grade E
2	2 1/2	1 500	2 000	4 000	—	—	3 000	4 000	8 000	—	—
2 1/2	3	1 500	2 000	4 000	5 000	7 500	3 000	4 000	8 000	10 000	15 000
3 and 3 1/2	4	—	—	4 000	5 000	7 500	—	—	8 000	10 000	15 000
4	5	—	—	4 000	5 000	7 500	—	—	8 000	10 000	15 000
5	5	—	—	4 000	5 000	7 500	—	—	8 000	10 000	15 000

Table C.2 — Fluid end of double acting mud-pump piston rods and piston body bores
(see Figures 12 and 13 for illustration of dimension symbols)

Dimensions in inches

Piston & rod taper number	Rod diam. range[a]	Piston rod					Piston			Piston & rod taper, in/ft on diam.	Standoff *S*		Thread designation
		Length of rod end	Major diam. rod taper	Length of taper	Length of perfect thread	Diam. of thread boss	Gauge point piston diam.	Diam. of cylindrical bore	Centre of piston				
		± 1/16	± 0,001	± 1/16	± 1/8	$\left(^{0}_{-1/16}\right)$	± 0,002	± 1/64		± 0,002			
	A	*B*	*C*	*D*	*E*	*F*	*G*[c]	*H*	*J*	*K*	min.	max.	
1	1 to 1 7/32	3 7/8	1,000	1 1/2	1 3/4	—	0,979	29/32	1 3/8	1,000	1/4	—	7/8-9UNC-2A
2	1 1/4 to 1 15/32	5 1/8	1,250	2 1/2	2 3/8	—	1,229	1 1/32	1 7/8	1,000	1/4	—	1-8UNC-2A
3	1 1/2 to 1 27/32	7 1/8	1,500	2 3/8	3 1/2	—	1,474	1 9/32	2 11/16	1,250	1/4	—	1 1/4-8UN-2A
4	1 7/8 to 2 7/32	8	1,875	4	3 1/2	—	1,854	1 9/16	2 15/16	1,000	1/4	—	1 1/2-8UN-2A
5	2 1/4 to 2 23/32	8 5/8	2,250	4	4 1/8	—	2,229	1 15/16	2 15/16	1,000	1/4	—	1 7/8-8UN-2A
6	2 3/4 to 2 31/32	9 1/8	2,750	4 1/2	4 1/8	—	2,279	2 3/8	2 15/16	1,000	1/4	—	2 1/4-8UN-2A
5HP[b]	2 3/4 to 3 1/2	8 5/8	2,225	3 3/4	4 3/8	1 11/16	2,229	1 15/16	2 11/16	1,000	0,041	0,113	1 7/8-8UN-2A
6HP	3 to 3 1/2	9 1/8	2,725	4 1/4	4 3/8	2 1/16	2,729	2 3/8	2 11/16	1,000	0,041	0,113	2 1/4-8UN-2A

[a] Selected diameter tolerances for API rod numbers 1 and 2: $\left(^{+0,010}_{-0,005}\right)$ in . For rod number 3 and larger; $\left(^{+0,010}_{0}\right)$ in .

[b] Recommended as a substitute for API 6HP piston for reduced liner sizes only.

[c] Dimension G, relates to dimension *S*, minimum only (standoff).

Table C.3 — Fluid end of single acting mud-pump piston rods and piston body bores
(see Figure 14 for illustration of dimension symbols)

Dimensions in inches

Piston & rod connection number	Connection diameter, nominal	Piston rod					Piston bore
		Rod diameter	Length of rod end ± 1/16	Start of thread from shoulder max.	Shoulder diameter ± 1/64	Thread designation	
		A	*B*	*C*	*D*		
SA-2	1	0,997 to 0,999	4 3/16	1 1/2	2	1-8UNC-2A	1,000 to 1,003
SA-4	1 1/2	1,497 to 1,499	5 7/16	1 7/8	3 1/4	1 1/2-8UN-2A	1,500 to 1,503

Table C.4 — Mud-pump valve pots (see Figure 20 for illustration of dimension symbols)

Dimensions in inches

Pot size	Valve pot dimensions								Spring mounting dimensions		
	A	*B*/ft	*C*	*D*	*E*	*F*	*G*	*J*	*L*	*M*	*N*
1	2 7/8	2	1	3 1/4	Solid	1 3/4	Solid	2 1/4	1	2 1/2	2 1/2
2	3 3/8	2	1 1/8	3 3/4	13/16	2 1/4	3 3/8	2 1/2	1 3/4	3	3 1/4
3	3 7/8	2	1 1/4	4 1/4	13/16	2 1/4	3 3/4	2 5/8	1 3/4	3	3 1/2
4	4 3/8	2	1 3/8	4 3/4	13/16	2 3/4	4 1/8	2 3/4	2	3	3 3/4
5	5	2	1 1/2	5 3/8	1 5/16	3	4 7/8	3 1/8	2 3/4	3 3/4	4 1/4
5,5	5 3/8	2	1 5/8	5 3/4	1 5/16	3 1/4	5 1/4	3 3/8	2 3/4	3 3/4	4 1/2
6	5 5/8	2	1 3/4	6	1 5/16	3 1/4	5 1/4	3 3/8	2 3/4	3 3/4	4 1/2
7	6 1/4	2	2	6 5/8	1 5/16	3 1/2	5 5/8	3 3/4	2 3/4	3 3/4	4 3/4
8	7	2	2 1/4	7 3/8	1 5/16	3 3/4	6	3 7/8	2 3/4	3 3/4	5
9	7 3/4	2	2 1/2	8 1/8	1 5/16	4	6 3/8	4 1/8	2 3/4	3 3/4	5 1/4
10	8 1/2	2	2 7/8	8 7/8	1 5/16	4 1/4	6 3/4	4 7/8	2 3/4	3 3/4	5 1/2
11	9 1/2	2	3 1/4	9 7/8	1 5/16	4 1/2	7 1/8	5 3/8	2 3/4	3 3/4	5 3/4

Table C.5 — Tapered thread and plain gauges[a] (see Figure 23 for illustration of dimension symbols)

Dimensions in inches at 68 °F

Taper thread number	Nom. size	Outside diam. of ring	Tapered thread gauges[b]						Tapered plain gauges		
			Pitch diam. at gauge point	Major diam. at gauge point	Minor diam. at gauge point	Diam. of fitting plate	Length of plug & ring	Diam. of counter-bore	Diam. of plug at large end	Diam. of ring at large end	Length of plug & ring
		D_R				D_P	L_{PT} & L_{RT}	D_C	D_{EP}	D_{ER}	L_{PP} & L_{RP}
T1	1	2 3/8	0,863 40	0,919 56	0,807 24	0,680	1,650 0	1,146	0,969 56	0,857 24	1,250 0
T2	1 1/8	2 1/2	0,988 25	1,044 41	0,932 09	0,805	1,806 2	1,271	1,094 41	0,982 09	1,406 2
T3	1 1/4	2 5/8	1,113 20	1,169 36	1,057 04	0,930	1,962 5	1,396	1,219 36	1,107 04	1,562 5
T4	1 3/8	2 3/4	1,238 00	1,294 16	1,181 84	1,055	2,118 8	1,521	1,344 16	1,231 84	1,718 8
T5	1 1/2	2 7/8	1,362 95	1,419 11	1,306 79	1,180	2,275 0	1,646	1,469 11	1,356 79	1,875 0
T6	1 5/8	3	1,487 90	1,544 06	1,431 47	1,305	2,431 2	1,771	1,594 06	1,481 74	2,031 2
T7	1 3/4	3 1/8	1,612 75	1,668 91	1,556 59	1,430	2,587 5	1,896	1,718 91	1,606 59	2,187 5
T8	1 7/8	3 1/4	1,737 65	1,793 81	1,681 49	1,555	2,743 8	2,021	1,843 81	1,731 49	2,343 8
T9	2	3 3/8	1,862 60	1,918 76	1,806 44	1,680	2,900 0	2,146	1,968 76	1,856 44	2,500 0
T10	2 1/4	3 5/8	2,112 40	2,168 56	2,056 24	1,929	3,212 5	2,395	2,218 56	2,106 24	2,812 5
T11	2 1/2	3 7/8	2,362 30	2,418 46	2,306 14	2,179	3,525 0	2,645	2,468 46	2,356 14	3,125 0
T12	2 3/4	4 5/8	2,612 15	2,668 31	2,555 99	2,429	3,837 5	2,895	2,718 31	2,605 99	3,437 5
T13	3	4 7/8	2,861 95	2,918 11	2,805 79	2,679	4,150 0	3,145	2,968 11	2,855 79	3,750 0
T14	3 1/4	5 1/8	3,111 85	3,168 01	3,055 69	2,929	4,462 5	3,395	3,218 01	3,105 69	4,062 5
T15	3 1/2	5 3/8	3,361 80	3,417 96	3,305 64	3,179	4,775 0	3,645	3,467 96	3,355 64	4,375 0
T16	4	5 7/8	3,861 55	3,917 71	3,805 39	3,679	5,400 0	4,145	3,967 71	3,855 39	5,000 0
T17	4 1/2	6 3/8	4,361 30	4,417 46	4,305 14	4,178	6,025 0	4,644	4,467 46	4,355 14	5,625 0
T18	5	6 7/8	4,861 05	4,917 21	4,804 89	4,678	6,650 0	5,144	4,967 21	4,854 89	6,250 0
T19	5 1/2	7 3/8	5,360 85	5,417 01	5,304 69	5,178	7,275 0	5,644	5,467 01	5,354 69	6,875 0
T20	6	7 7/8	5,860 70	5,916 86	5,804 54	5,678	7,900 0	6,144	5,966 86	5,854 54	7,500 0

[a] Taper for all sizes is 2,000 0 in/ft on diameter.

[b] All threads are 8 TPI, pitch = 0,125 0 in.

Table C.6 — Pin go and no-go gauges[a] (for straight-threaded portion of tapered-thread connection)
(see Figure 24 for illustration of dimension symbols))

Dimensions in inches at 68 °F

Taper thread number	Nom. size	Full form major diam.	Go gauges				Ring minor diam.	No-go gauges				
			Truncated major diam.	Pitch diam.	Thread length	Ring length		Truncated major diam.	Pitch diam.	Thread length	Ring length	Ring minor diam.
		B_S	B_{ST}	E_S	L_{TS}	L_N	K_N	B_{ST}	L_S	L_{TS}	L_N	K_N
T1	1	0,973 1	0,956 0	0,916 8	2 1/8	15/16	0,860 5	0,938 1	0,910 0	1 1/2	11/16	0,881 9
T2	1 1/8	1,098 0	1,080 9	1,041 7	2 1/8	15/16	0,985 4	1,062 9	1,034 8	1 1/2	11/16	1,006 7
T3	1 1/4	1,223 0	1,205 9	1,166 7	2 3/8	1 1/8	1,110 4	1,187 8	1,159 7	1 5/8	3/4	1,131 6
T4	1 3/8	1,347 9	1,330 8	1,291 6	2 3/8	1 1/8	1,235 3	1,312 5	1,284 4	1 5/8	3/4	1,256 3
T5	1 1/2	1,472 9	1,455 8	1,416 6	2 3/8	1 1/8	1,360 3	1,437 4	1,409 3	1 5/8	3/4	1,381 2
T6	1 5/8	1,597 9	1,580 8	1,541 6	2 7/8	1 1/4	1,485 3	1,562 3	1,534 2	1 7/8	13/16	1,506 1
T7	1 3/4	1,722 8	1,705 7	1,666 5	2 7/8	1 1/4	1,610 2	1,687 1	1,659 0	1 7/8	13/16	1,630 9
T8	1 7/8	1,847 8	1,830 7	1,791 5	2 7/8	1 1/4	1,735 2	1,811 9	1,783 8	1 7/8	13/16	1,755 7
T9	2	1,972 8	1,955 7	1,916 5	2 7/8	1 1/4	1,860 2	1,936 8	1,908 7	1 7/8	13/16	1,880 6
T10	2 1/4	2,222 7	2,205 6	2,166 4	3	1 3/8	2,110 1	2,186 5	2,158 4	2	7/8	2,130 3
T11	2 1/2	2,472 7	2,455 6	2,416 4	3 1/4	1 1/2	2,360 1	2,436 3	2,408 2	2	7/8	2,380 1
T12	2 3/4	2,722 6	2,705 5	2,666 3	3 1/2	1 5/8	2,610 0	2,686 1	2,658 0	2	7/8	2,629 9
T13	3	2,972 5	2,955 4	2,916 2	3 3/4	1 3/4	2,859 9	2,935 8	2,907 7	2	7/8	2,879 6
T14	3 1/4	3,222 5	3,205 4	3,166 2	4	1 7/8	3,109 9	3,185 6	3,157 5	2	15/16	3,129 4
T15	3 1/2	3,472 5	3,455 4	3,416 2	4 1/4	2	3,359 9	3,435 5	3,407 4	2	15/16	3,379 3
T16	4	3,972 4	3,955 3	3,916 1	4 1/4	2	3,859 8	3,935 1	3,907 0	2	15/16	3,878 9
T17	4 1/2	4,472 3	4,455 2	4,416 0	4 1/4	2	4,359 7	4,434 7	4,406 6	2 1/8	1	4,378 5
T18	5	4,972 2	4,955 1	4,915 9	4 1/4	2	4,859 6	4,934 3	4,906 2	2 1/8	1	4,878 1
T19	5 1/2	5,472 1	5,455 0	5,415 8	4 1/4	2	5,359 5	5,434 0	5,405 9	2 1/8	1	5,377 8
T20	6	5,972 1	5,955 0	5,915 8	4 1/4	2	5,859 5	5,933 7	5,905 6	2 1/8	1	5,877 5

[a] All threads are 8 TPI, pitch = 0,125 0 in.

Table C.7 — Box go and no-go gauges[a] (for locknut) (see Figure 25 for illustration of dimension symbols)

Dimensions in inches at 68 °F

Tapered thread length	**Nom. size**	**Go gauges**			**No-go gauges**		
		Major diam. B_S	Pitch diam. E_S	Thread length L_T	Major diam. B_S	Pitch diam. E_S	Thread length L_T
T1	1	0,975 1	0,918 8	1	0,955 7	0,927 6	5/8
T2	1 1/8	1,100 1	1,043 8	1	1,080 9	1,052 8	5/8
T3	1 1/4	1,225 1	1,168 8	1 1/4	1,206 1	1,178 0	3/4
T4	1 3/8	1,350 1	1,293 8	1 1/4	1,331 2	1,303 1	3/4
T5	1 1/2	1,475 1	1,418 8	1 1/4	1,456 4	1,428 3	3/4
T6	1 5/8	1,600 1	1,543 8	1 1/4	1,581 6	1,553 5	7/8
T7	1 3/4	1,725 1	1,668 8	1 1/4	1,706 7	1,678 6	7/8
T8	1 7/8	1,850 1	1,793 8	1 1/4	1,831 9	1,803 8	7/8
T9	2	1,975 1	1,918 8	1 1/4	1,957 0	1,928 9	7/8
T10	2 1/4	2,225 1	2,168 8	1 3/8	2,207 3	2,179 2	7/8
T11	2 1/2	2,475 1	2,418 8	2	2,457 5	2,429 4	7/8
T12	2 3/4	2,725 1	2,668 8	2 1/8	2,707 7	2,679 6	1
T13	3	2,975 1	2,918 8	2 1/8	2,958 0	2,929 9	1
T14	3 1/4	3,225 1	3,168 8	2 1/4	3,208 2	3,180 1	1
T15	3 1/2	3,475 1	3,418 8	2 1/4	3,458 4	3,430 3	1
T16	4	3,975 1	3,918 8	2 1/4	3,958 8	3,930 7	1
T17	4 1/2	4,475 1	4,418 8	2 1/4	4,459 1	4,431 0	1
T18	5	4,975 1	4,918 8	2 1/4	4,959 5	4,931 4	1
T19	5 1/2	5,475 1	5,418 8	2 1/4	5,459 8	5,431 7	1
T20	6	5,975 1	5,918 8	2 1/4	5,960 1	5,932 0	1

[a] All threads are 8 TPI, pitch = 0,125 0 in.

Annex D
(informative)

Recommended piston mud-pump nomenclature and maintenance

D.1 Piston mud-pump nomenclature

The intent of this annex is to standardize nomenclature for principal parts of mud pumps, excluding a relatively small number of associated parts. This will provide a common language for the industry, particularly valuable for communication.

D.2 Old designs

This language is to be used for old pumps as well as newly designed pumps, even though the manufacturer's literature might not be consistent with this International Standard. Manufacturers are expected to comply with this International Standard on newly designed pumps. For old designs, their literature should be made to comply when it is opportune to do so. In communications between user and manufacturer, the part number should be used as positive identification where nomenclature inconsistencies occur.

D.3 Types

This nomenclature is applicable to duplex and triplex power-piston mud pumps.

D.4 Designation

Power end (Table D.1 and Figures D.1, D.2 and D.3) and fluid end parts (Table D.2 and Figure D.4, and Table D.3 and Figure D.5) are grouped in separate categories. Right- and left-hand parts for all groups are determined by the same rule. The rule is: when standing at the power end and looking over the power end toward the fluid end, those parts to the right of the centreline are designated as right-hand when needed to differentiate from other like parts; and, similarly, those to the left are designated as left-hand. For triplex pumps, those parts on the centreline needing differentiation from like parts are designated centre.

Table D.1 — Power-end parts, duplex and triplex pumps

Part number	Description
101	Frame
102	Crankshaft
103	Main gear
104	Pinion
105	Pinion shaft
106	Connecting rod[a]
107	Crosshead[a]
108	Crosshead pin[a]
109	Connecting rod bearing[a]
110	Crankshaft bearing (main)[a]
111	Crankshaft bearing housing[a]
112	Pinion shaft bearing[a]
113	Crosshead pin bearing[a]
114	Crosshead extension rod (pony)[a]
115	Crosshead extension rod wiper[a]

[a] Exact location of these parts designated as right, or left, and centre if triplex pump.

Table D.2 — Fluid-end parts, duplex pumps

Part number	Description
201	Fluid end – When fluid end is sectionalized, refer to right or left
202[a]	Cylinder head
203[a]	Cylinder head cover
204[b]	Valve cover
205	Valve guide
206	Valve spring
207	Valve seat
208[a]	Liner
209[a]	Liner packing
210[a]	Piston
211[a]	Piston rod
212[a]	Stuffing box
213[a]	Junk ring
214[a]	Stuffing box packing
215[a]	Gland
216[a]	Gland nut

NOTE For further detailed nomenclature see IADC *Drilling Manual* [12].

[a] Exact location of these parts designated right or left.

[b] Exact location of these parts designated right or left, or when more convenient, the IADC *Drilling Manual* numerals may be used.

Table D.3 — Fluid end parts, triplex pumps

Part number	Description
301	Fluid end – When fluid end is sectionalized, refer to right, left or centre
302[a]	Valve cover
303[a]	Valve guide
304[a]	Valve spring
305[a]	Valve seat
306[b]	Liner
307[b]	Liner packing
308[b]	Piston
309[b]	Piston rod
310[b]	Liner spray

NOTE For further detailed nomenclature see IADC *Drilling Manual* [12].

[a] Exact location of these parts designated right or left.

[b] Exact location of these parts designated right or left; or when more convenient, the IADC *Drilling Manual* numerals may be used.

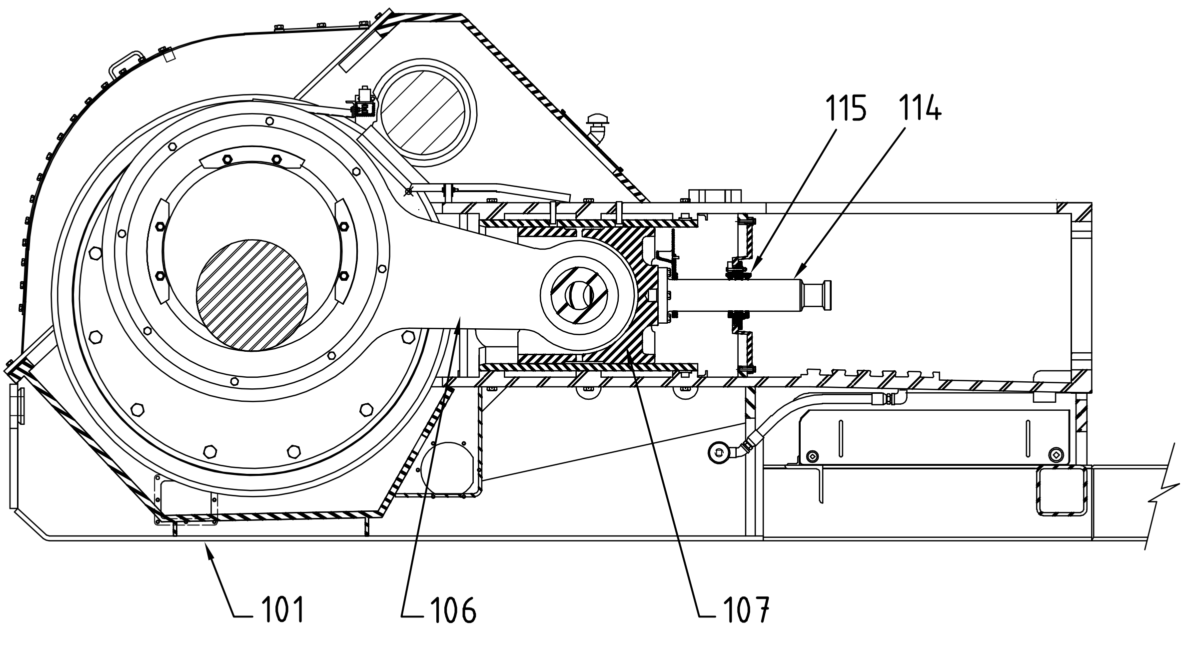


Figure D.1 — Section through power end (see Table D.1 for nomenclature)

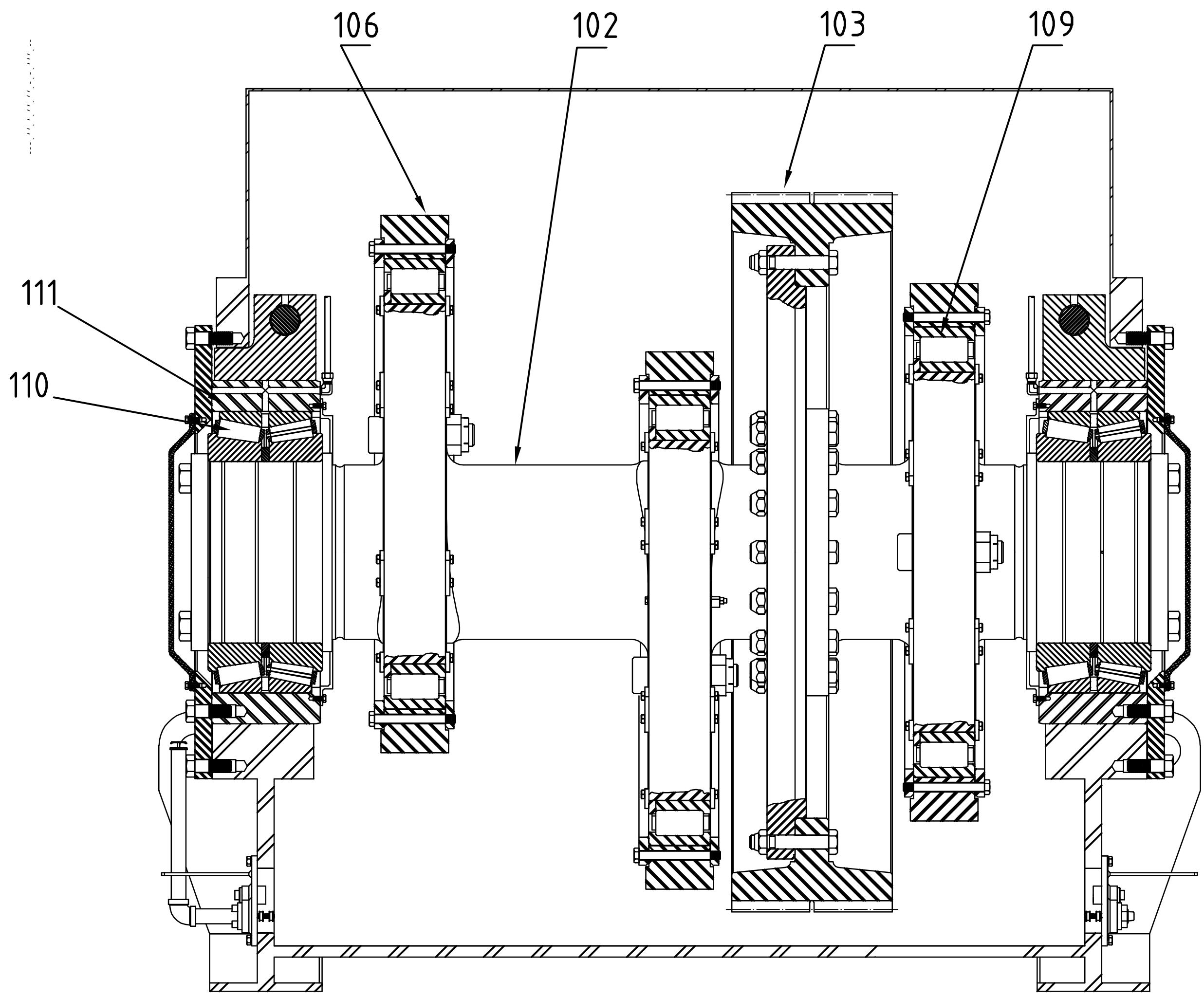


Figure D.2 — Section through crankshaft (see Table D.1 for nomenclature)

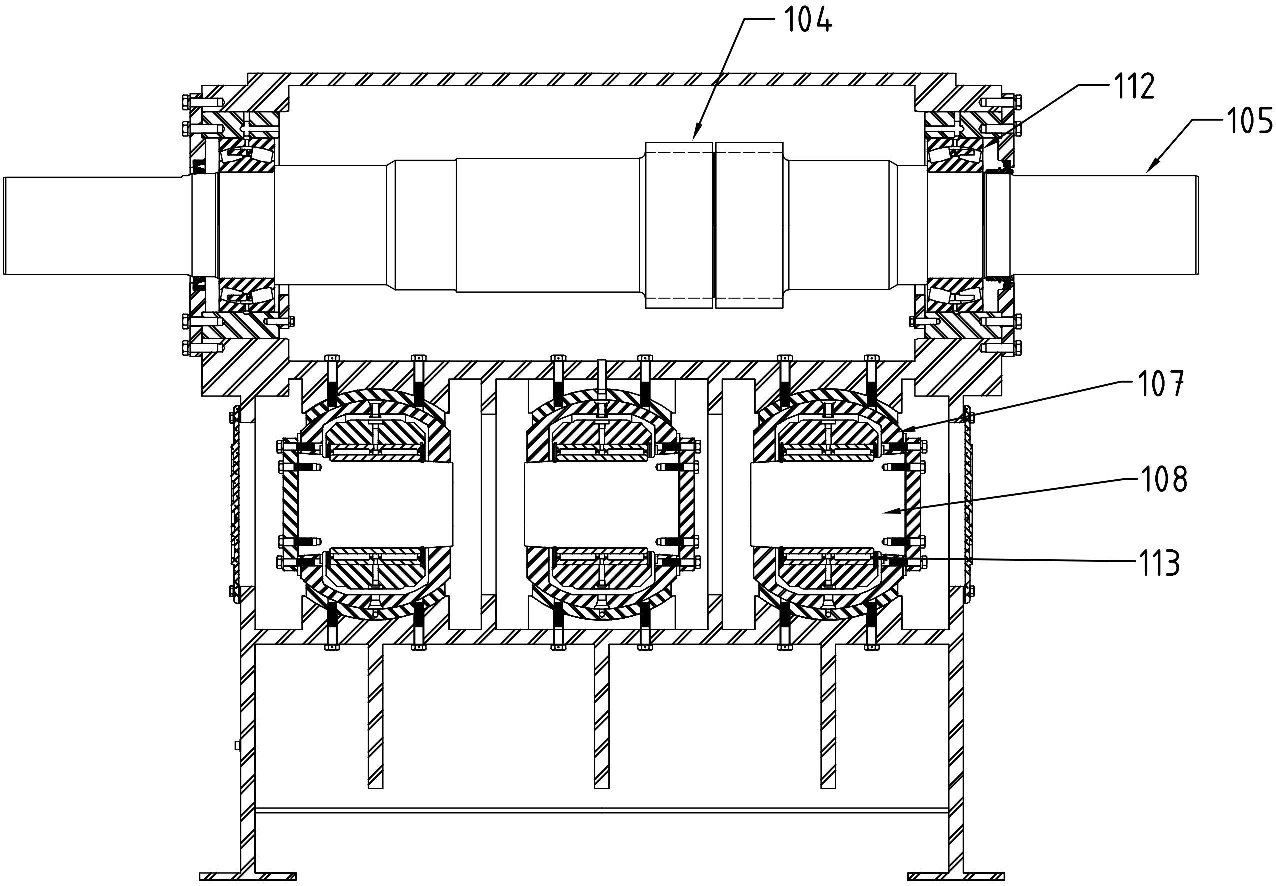


Figure D.3 — Section through pinion shaft and crosshead (see Table D.1 for nomenclature)

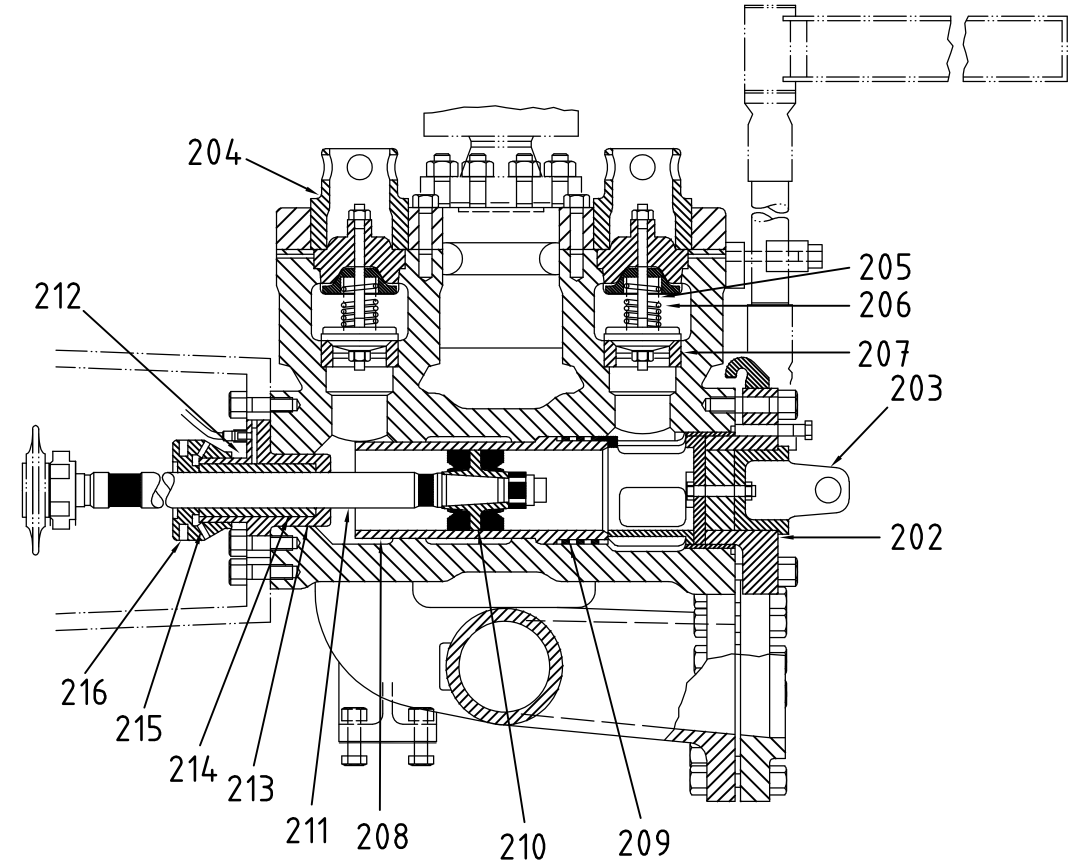


Figure D.4 — Fluid end of duplex double-acting mud pump (see Table D.2 for nomenclature)

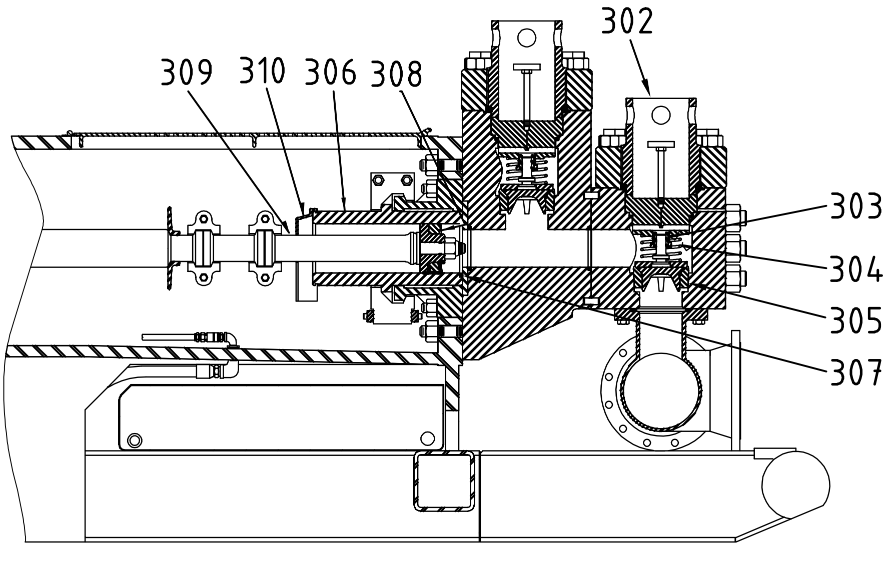


Figure D.5 — Fluid end of triplex single-acting mud pump (see Table D.3 for nomenclature)

Bibliography

[1] ISO/TR 9769, *Steel and iron — Review of available methods of analysis*

[2] ISO 10012-1, *Quality assurance requirements for measuring equipment — Part 1: Metrological confirmation system for measuring equipment*

[3] ANSI/AGMA 6010-F97, *Spur, Helical, Herringbone, and Bevel Enclosed Drives*

[4] API[9] Spec 7, *Rotary Drill Stem Elements*

[5] API Spec 7K, *Drilling and Well Servicing Equipment*

[6] ASTM A 488, *Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel*

[7] ASTM A 668, *Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use*

[8] ASTM A 781, *Standard Specification for Castings, Steel and Alloy, Common Requirements for General Industrial Use*

[9] ASTM A 788, *Standard Specification for Steel Forgings, General Requirements*

[10] DOD[10] MIL STD 120, *Gauge Inspection*

[11] FEM[11], *Rules for the design of hoisting appliances*

[12] IADC[12], *Drilling Manual*

[13] MIL-H-6875F, *Heat-treatment of Steels, Aircraft Practice Process*

[14] SAE[13] AS 1260, *Equivalent Sections of Certain Shapes to Round Bars*

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9) American Petroleum Institute, 1220 L St NW, Washington DC, 20005, USA.

10) Department of Defence, Pentagon, Washington DC, 20301, USA.

11) Fédération Européenne de la Manutention, 39-41, rue Louis-Blanc, 92400 Courbevoie, 92038 Paris, La Défense Cedex, France.

12) International Association of Drilling Contractors, PO Box 4287, Houston, TX, 77210-4287, USA.

13) Society of Automotive Engineers, Two Pennsylvania Plaza, New York, NY 10001, USA.

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