Drilling and Production Hoisting Equipment (PSL 1 and PSL 2)

API SPECIFICATION 8C
FIFTH EDITION, APRIL 2012

EFFECTIVE DATE: OCTOBER 1, 2012

ERRATA, MAY 2014

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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Drilling and Production Hoisting Equipment
(PSL 1 and PSL 2)

1 Scope

This Standard provides requirements for the design, manufacture and testing of hoisting equipment suitable for use in drilling and production operations.

This Standard is applicable to the following drilling and production hoisting equipment:

a) hoisting sheaves;

b) travelling blocks and hook blocks;

c) block-to-hook adapters;

d) connectors and link adapters;

e) drilling hooks;

f) tubing hooks and sucker-rod hooks;

g) elevator links;

h) casing elevators, tubing elevators, drill-pipe elevators and drill-collar elevators;

i) sucker-rod elevators;

j) rotary swivel-bail adapters;

k) rotary swivels;

l) power swivels;

m) power subs;

n) spiders, if capable of being used as elevators;

o) wire-line anchors;

p) drill-string motion compensators;

q) kelly spinners, if capable of being used as hoisting equipment;

r) pressure vessels and piping mounted onto hoisting equipment;

s) safety clamps, if capable of being used as hoisting equipment;

t) guide dollies for traveling equipment (e.g. hooks, blocks, etc.).

This Standard establishes requirements for two product specification levels (PSLs). These two PSL designations define different levels of technical requirements. All the requirements of Section 4 through Section 11 are applicable to PSL 1 unless specifically identified as PSL 2. PSL 2 includes all the requirements of PSL 1 plus the additional practices as stated herein.

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

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.

API Specification 5B, *Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*

API Specification 5CT, *Specification for Casing and Tubing*

API Specification 7-1, *Specification for Rotary Drill Stem Elements*

API Specification 7-2, *Specification for Threading and Gauging of Rotary Shouldered Thread Connections*

API Recommended Practice 9B, *Application, Care, and Use of Wire Rope for Oil Field Service*

ASME B31.3 [1], *Chemical Plant and Petroleum Refinery Piping*

ASME Boiler and Pressure Vessel Code, 2010, Section V, *Nondestructive Examination*; Section VIII, DIV 1, *Rules for Construction of Pressure Vessels*; Section IX, *Welding and Brazing Qualifications*

ASTM A 370 [2], *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A388, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings*

ASTM A488, *Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel*

ASTM A770, *Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications*

ASTM E4, *Load Verification of Testing Machines*

ASTM E125, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings*

ASTM E165, *Standard Test Method for Liquid Penetrant Examination*

ASTM E186, *Standard Reference Radiographs for Heavy-Walled (2 to 4 $^1/_2$-in. (51 to 114-mm)) Steel Castings*

ASTM E280, *Standard Reference Radiographs for Heavy-Walled (4$^1/_2$ to 12-in. (114 to 305-mm)) Steel Castings*

ASTM E428, *Standard Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection*

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (51 mm) in Thickness*

ASTM E709, *Standard Guide for Magnetic Particle Examination*

ASNT, SNT-TC-1A [3], *Recommended practice for personnel qualification and certification in nondestructive testing*

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1 ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.
2 ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
3 American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228, www.asnt.org.

AWS D1.1 [4], *Structural Welding Code*

AWS QC1, *Standard for AWS Certification of Welding Inspectors*

EN 287-1 [5], *Qualification test of welders – Fusion welding – Steels*

[reference deleted]

ISO 15614-1 [6], *Specification and qualification of welding procedures for metallic materials—Welding procedure test—Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

MSS SP-55 [7], *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 Abbreviations

3.1 Terms and Definitions

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

3.1.1

bearing-load rating

Calculated maximum load for bearings subjected to the primary load.

3.1.2

design load

Sum of static and dynamic loads that would induce the maximum allowable stress in an item.

3.1.3

design safety factor

Factor to account for a certain safety margin between the maximum allowable stress and the specified minimum yield strength of a material.

3.1.4

design verification test

Test performed 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

Standard for comparing various shaped sections to round bars, used for determining the response to hardening characteristics when heat treating low-alloy and martensitic corrosion-resistant steels.

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4 American Welding Society, 550 NW LeJeune Road, Miami, Florida 33126, www.aws.org.

5 European Committee for Standardization, Avenue Marnix 17, B-1000, Brussels, Belgium, www.cen.eu.

6 International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.

7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park Street, NE, Vienna, Virginia 22180-4602, www.mss-hq.com.

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
An indication revealed by NDE, having a length of at least three times the width.

3.1.9
load rating
Maximum operating load, both static and dynamic, to be applied to the equipment.

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

3.1.10
maximum allowable stress
The specified minimum yield strength divided by the design safety factor.

3.1.11
primary load
Axial load that equipment is subjected to in operations.

3.1.12
primary load-carrying component
Component of the equipment through which the primary load is carried.

3.1.13
product specification level
Degree of controls applied on materials and processes for the primary load-carrying components of the equipment.

NOTE The two product specification levels are identified by the code PSL 1 or PSL 2.

3.1.14
proof load test
Production load test performed to validate the load rating of a unit.

3.1.15
repair
Removal of defects from, and refurbishment of, a component or assembly by welding, during the manufacture of new equipment.

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

3.1.16
rounded indication
An indication revealed by NDE, with a circular shape or with an elliptical shape having a length of less than three times the width.

3.1.17
safe working load
The design load minus the dynamic load.

3.1.18
size class
Designation by which dimensionally-interchangeable equipment of the same maximum load rating is identified.

3.1.19
size range
Range of tubular diameters covered by an assembly.

3.1.20
special process
An operation that can 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 Abbreviations

For the purposes of this Standard, the following abbreviated terms apply.

ER	equivalent round
HAZ	heat affected zone
PSL	product specification level
NDE	nondestructive examination
PLC	principal loading condition
PWHT	post-weld heat treatment

4 Design

4.1 General

Hoisting equipment shall be designed, manufactured and tested so 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 simple and safe operation.

4.2 Design Conditions

The following design conditions shall apply:

a) the operator of the equipment shall be responsible for determination of the safe working load for any hoisting operation;

b) the design and minimum operating temperature shall be –20 °C (–4 °F), unless supplementary requirement SR 2 has been applied (see A.3).

Caution—The equipment should not be used at the full load rating at temperatures below –20 °C (–4 °F) unless appropriate materials with the required toughness properties at lower design temperatures have been used (see A.3).

4.3 Strength Analysis

4.3.1 General

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

4.3.1.2 The strength analysis shall be generally based on the elastic theory. An ultimate strength (plastic) analysis may, however, be used where appropriate. Finite-element mesh analysis, in conjunction with analytical methods, may be used.

4.3.1.3 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.

4.3.2 Simplified Assumptions

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

4.3.3 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 5.5.

4.3.4 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 AS_{max} as calculated by Equation (1).

$$AS_{\text{max}} = \frac{YS_{\text{min}}}{SF_{\text{D}}} \tag{1}$$

where

YS_{min} is the specified minimum yield strength;

SF_{D} is the design safety factor.

4.3.5 Ultimate Strength (Plastic) Analysis

4.3.5.1 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 4.3.4.

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

4.3.5.2 In the case of plastic analysis, the equivalent stress as defined in 4.3.4 shall not exceed the maximum allowable stress AS_{max} as calculated by Equation (2).

$$AS_{max} = \frac{TS_{min}}{SF_D} \qquad (2)$$

where

TS_{min} is the specified minimum ultimate tensile strength;

SF_D is the design safety factor.

4.3.6 Stability Analysis

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

4.3.7 Fatigue Analysis

The fatigue analysis shall be based on a period of time 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 [2].

4.3.8 Rotary-shouldered Connections

4.3.8.1 Design Verification

API rotary-shouldered connections are exempt from design verification testing as described in 5.3.2.

4.3.8.2 Rotary-shouldered Connections subjected only to Drill Stem Loads

Rotary-shouldered connections subjected only to drill stem loads shall be designed in accordance with API 7-1 and API 7-2.

4.3.8.3 Rotary-shouldered Connections subjected to Hoisting Loads other than Drill Stem Loads

API rotary-shouldered connections (RSC) subjected to hoisting loads other than drill stem loads (e.g. riser or casing running) shall be rated in accordance with this section. The manufacturer shall provide a recommended range of make-up torque (MUT), over which the RSC tensile load rating shall apply.

For any API rotary-shouldered connection, the rating shall be calculated as follows (see Figure 1 for locations of tensile areas):

Tensile load rating (for pin) in SI units, kN = $(YS_{min})\,(A_p)/(SF_D \times 1000)$

Tensile load rating (for box) in SI units, kN = $(YS_{min})\,(A_{bt})/(SF_D \times 1000)$

or

Tensile load rating (for pin) in USC units, short tons = $(YS_{min})\,(A_p)/(SF_D \times 2)$

Tensile load rating (for box) in USC units, short tons = $(YS_{min})\,(A_{bt})/(SF_D \times 2)$

where

YS_{min} is the specified minimum yield strength, MPa (ksi);

SF_D is the design safety factor (see 4.7);

A_p is the pin cross sectional area as defined by:

$A_p = \frac{\pi}{4}\left[(C-B)^2 - ID^2\right]$ mm² (in.²), without stress-relief groove (see API 7-2, Figure 1),

or

$A_p = \frac{\pi}{4}\left[D_{SRG}^2 - ID^2\right]$ mm² (in.²), with stress-relief groove (see API 7-2, Figure 9);

A_{bt} is the box cross sectional area as defined by

$A_{bt} = \frac{\pi}{4}\left[OD^2 - D_{CB}^2\right]$ mm² (in.²), without stress-relief groove, with or without boreback stress-relief contour (see API 7-2, Figure 2 and Figure 8),

or

$A_{bt} = \frac{\pi}{4}\left[OD^2 - D_{BG}^2\right]$ mm² (in.²), with stress-relief groove (see API 7-2, Figure 10);

C is the pitch diameter of thread at gauge point, mm (in.), (see API 7-2, Table 1, or Table A.1);

ID is the inside diameter of the pin, mm (in.);

D_{SRG} is the diameter of the pin stress-relief groove, mm (in.), (see API 7-2, Table 5, or Table A.5);

OD is the outside diameter of the box, mm (in.);

D_{CB} is the diameter of the cylinder of the box boreback stress-relief contour, mm (in.), (see API 7-2, Table 5, or Table A.5);

D_{BG} is the diameter of the box stress-relief groove, mm (in.), (see API 7-2 Table 5 or Table A.5);

$B = 2\left(\frac{H}{2} - f_r\right) + T \times (3.175)$ in SI units, mm,

or

$B = 2\left(\frac{H}{2} - f_r\right) + T \times \left(1/8\right) \times \left(1/12\right)$ in USC units, in.;

H is the thread height not truncated, mm (in.), (see API 7-2, Table 2, or Table A.2);

f_r is the root truncation, mm (in.), (see API 7-2, Table 2 or Table A.2);

T is the taper, mm/mm (in./ft), (see API 7-2, Table 2 or Table A.2).

Alternatively, the tensile load rating of the rotary shouldered connection can be established by performing an alternative design verification test in accordance with 5.5.

4.4 Size Class

The size class shall represent the dimensional interchangeability and the load rating of equipment.

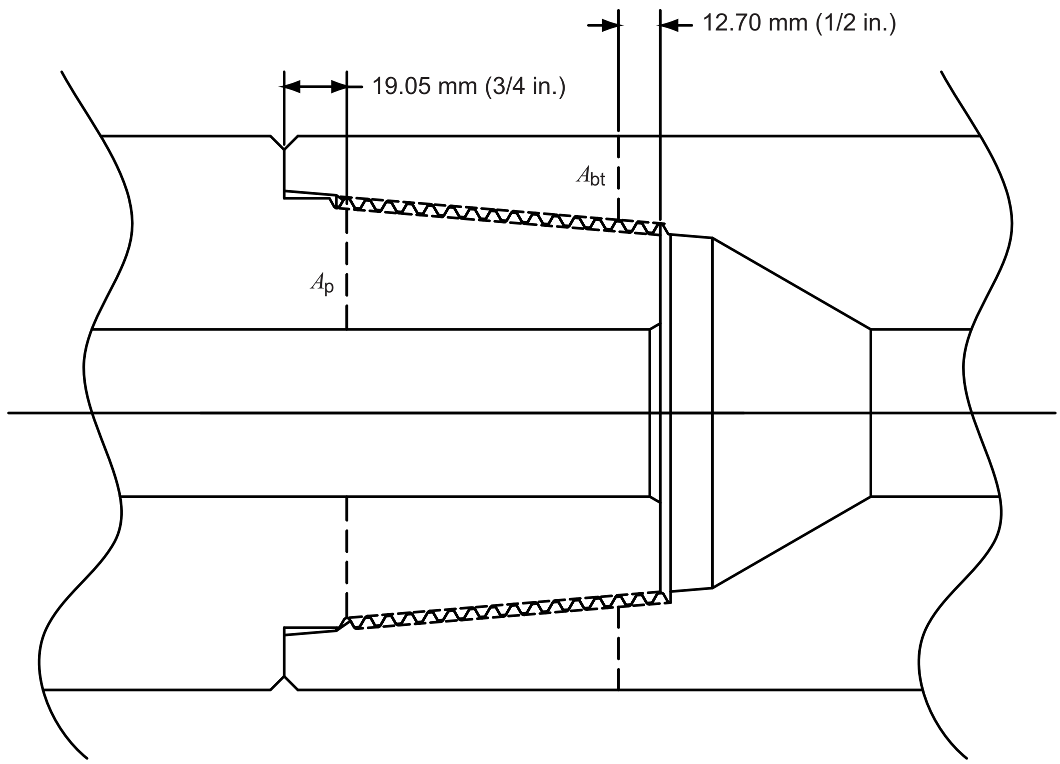


Figure 1—Locations of Tensile Areas for RSC Load Rating—Case without SRG's Shown

4.5 Contact Surface Radii

Figure 8, Figure 9, Figure 10, and Table 6 show radii of hoisting-tool contact surfaces. These contact radii are applicable to hoisting tools used in drilling (including tubing hooks), but all other work-over tools are excluded.

4.6 Rating

4.6.1 All hoisting equipment furnished under this Standard shall be rated as specified herein. Such ratings shall consist of a load rating for all equipment and a bearing-load rating for all equipment containing bearings within the primary load path.

4.6.2 The bearing-load rating is intended primarily to achieve consistency of ratings, but is also intended to provide a reasonable service life for bearings when used at loads within the equipment-load rating.

4.6.3 The load rating shall be based on the design safety factor as specified in 4.7, the specified minimum yield strength of the material used in the primary-load-carrying components and the stress distribution as determined by design calculations and/or data developed in a design verification load test as specified in 5.5.

4.6.4 The load rating shall be marked on the equipment (refer to Section 10).

4.7 Design Safety Factor

The design safety factor shall be established from Table 1.

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 load rating.

Table 1—Design Safety Factor

Load rating R kN (ton)	Design safety factor SF_D
1334 kN (150 short tons) and less	3.00
1334 kN (150 short tons) to 4448 kN (500 short tons) inclusive	$3.00 - [0.75 \times (R - 1\,334)/3\,114]$ [a] $(3.00 - [0.75 \times (R - 150)/350])$ [b]
Over 4448 kN (500 short tons)	2.25

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

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

4.8 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.

4.9 Dropped Objects

4.9.1 All components of hoisting equipment furnished under this Standard shall be designed and manufactured for prevention of potential dropped/falling objects.

4.9.2 The causes considered shall as a minimum include: vibration, improper maintenance, corrosion, shock load, and collision.

4.9.3 The potential for dropped/falling objects shall be addressed by prevention techniques, which include but are not limited to:

— design;

— specialty fasteners;

— lanyards, cabling or safety wire;

— guarding;

— integrated secondary barriers;

— other secondary retention devices or methods.

4.10 Specific Equipment

Refer to Section 9 for all additional equipment-specific design requirements.

4.11 Design Documentation

Documentation of the 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, mitigation of potential for dropped objects, and specification requirements, and pertinent requirements upon which the design is to be based.

The requirements shall also apply to design change documentation.

5 Design Verification Test

5.1 General

5.1.1 To ensure the integrity of equipment design, design verification testing shall be performed as specified below.

5.1.2 Design verification testing of equipment shall be carried out and/or certified by a department or organization independent of the design function.

5.1.3 Equipment which, by virtue of its simple geometric form, permits accurate stress analysis through calculation shall be exempted from design verification testing provided the accuracy of the calculation is confirmed by the performance of alternative calculations or by comparing the new design to similar proven designs. The design documents shall be reviewed and approved by a qualified person who is independent of the design function.

5.2 Sampling of Test Units

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

— A minimum of three units of the design shall be subjected to design verification testing. The test units shall be selected from the lower end, middle, and upper end of the size/rating range.

— Alternatively, the required number of test units shall be established on the basis that each test unit also qualifies one size or rating above and below that of the selected test unit.

NOTE The second option generally applies to limited product size/rating ranges.

5.3 Test Procedures

5.3.1 Functional Test

Load the test unit to the design load. After this load has been released, check the unit to verify that the functions of the equipment and its components have not been impaired by this loading.

5.3.2 Design Verification Test [8]

5.3.2.1 Apply strain gauges to the test unit at all places where high stresses are anticipated, provided that the configuration of the units permits such techniques. Tools such as finite-element analysis, models, brittle lacquer, etc. should be used to confirm the proper location of the strain gauges. Three element strain gauges should be applied in critical areas to permit determination of the shear stresses and to eliminate the need for exact orientation of the strain gauges.

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

a) For load ratings up to, and including 11,120 kN (1250 short tons),

$$\text{Design verification test load} = 0.8 \times R \times SF_{\mathrm{D}}\text{, but not less than } 2R \qquad (3)$$

where

R is the load rating in kilonewtons (short tons);

SF_{D} is the design safety factor as defined in 3.1.3 and 4.7.

[8] The test load factor is adjusted to make development and qualification of equipment with ratings above 11,120 kN (1250 short tons) practical.

b) For load ratings from 11,120 kN (1250 short tons) through 14,678 kN (1650 short tons),

$$\text{Design verification test load} = C \times R \tag{4}$$

where

In SI units, $C = 2 - 0.5 \times (R - 11{,}120)/3558$

In USC units, $C = 2 - 0.5 \times (R - 1250)/400$

c) For load ratings above 14,678 kN (1650 short tons),

$$\text{Design verification test load} = 1.5 \times R \tag{5}$$

5.3.2.3 Load the unit to the design verification test load. This test load should be applied carefully, reading the strain gauge values and observing the yield. The test unit should be loaded as many times as necessary to obtain adequate data.

5.3.2.4 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 5.6. Failure to meet this requirement or premature failure of any test unit shall be cause for a 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 size and rating as the one that failed.

5.3.2.5 Upon completion of the design verification test, disassemble the unit and check the dimensions of each part for evidence of yielding.

5.3.2.6 Individual parts of a unit may be tested separately if the holding fixtures simulate the load conditions applicable to the part in the assembled unit.

5.4 Determination of Load Rating

Determine the load rating from the results of the design verification test and/or the design and stress-distribution calculations required by Section 4. The stresses at that rating shall not exceed the values allowed in 4.3. Localized yielding is permitted at areas of contact. In a test unit that has been design-verification 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, redesign the affected part or parts to obtain the desired rating. Stress-distribution calculations may be used to establish the load rating of equipment only if the results of the analysis are shown to be within acceptable engineering allowances as verified by the design verification test prescribed by Section 5.

5.5 Alternative Design Verification Test Procedure and Rating

Destructive testing of the test unit may be used, provided an accurate yield and tensile strength of the material used in the equipment has been determined. This may be accomplished by using tensile-test specimens of the actual material in the part destructively tested and determining the yield-to-ultimate strength ratio. 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.

The ratio is then used to rate the equipment as shown in Equation (6) and Equation (7):

$$R = L_{\mathrm{B}} \frac{T_{\mathrm{R}}}{SF_{\mathrm{D}}} \tag{6}$$

$$T_{\mathrm{R}} = \frac{YS_{\mathrm{m}}}{TS_{\mathrm{a}}} \tag{7}$$

where

SF_{D} is the design safety factor (see 4.7);

YS_{m} is the minimum specified yield strength;

TS_{a} is the actual ultimate tensile strength;

L_{b} is the breaking load;

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.

5.6 Load Test Apparatus

Calibrate the loading apparatus used to simulate the working load on the test unit in accordance with ASTM E4 so as to ensure that the prescribed test load is obtained. For loads exceeding 3558 kN (400 short tons), verify the load-testing apparatus with calibration devices traceable to a Class A calibration device and having an uncertainty of less than 2.5 %.

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

5.7 Design Changes

When any change in design or manufacturing method changes the load rating, a supportive design verification test in conformance with Section 5 shall be carried out. The manufacturer shall evaluate all changes in design or manufacturing methods to determine whether the load rating is affected. This evaluation shall be documented.

5.8 Records

All design verification records and supporting data shall be subject to the same controls as specified for design documentation in 11.2.

6 Materials Requirements

6.1 General

All materials shall be suitable for the intended service.

The remainder of Section 6 describes the various material qualification, property and processing requirements for primary-load-carrying components and pressure-containing components unless otherwise specified.

6.2 Written Specifications

Materials shall be produced to a written material specification which shall, as a minimum, define the following parameters and limitations:

— mechanical property requirements;

— material qualification;

— processing requirements, including permitted melting, working and heat treatment;

— chemical composition and tolerances;

— repair-welding requirements.

The description of the working practice shall include the forging reduction-ratio.

6.3 Mechanical Properties

6.3.1 Materials shall meet the property requirements specified in the manufacturer's material specification.

6.3.2 The impact toughness shall be determined from the average of three tests, using full-size test pieces if the size of the component permits. If it is necessary for sub-size impact test pieces to be used, the acceptance criteria for impact values shall be those stated below but multiplied by the appropriate adjustment factor listed in Table 3. Sub-size test pieces of width less than 5 mm shall not be used.

6.3.3 For materials of a specified minimum yield strength of at least 310 MPa (45 ksi), the average impact toughness shall be at least 42 J (31 ft-lb) at –20 °C (–4 °F), with no individual value less than 32 J (24 ft-lb).

6.3.4 For materials with a specified minimum yield strength of less than 310 MPa (45 ksi), the average impact toughness shall be 27 J (20 ft-lb) at –20 °C (–4 °F) with no individual value less than 20 J (15 ft-lb).

6.3.5 For design temperatures below –20 °C (–4 °F) (e.g. arctic service), supplementary impact toughness requirements shall apply, see A.3, SR2.

6.3.6 Where the design requires through-thickness properties, materials shall be tested for reduction of area in the through-thickness direction in accordance with ASTM A770. The minimum reduction shall be 25 %.

6.3.7 PSL 2 components shall be fabricated from materials meeting the applicable requirements for ductility specified in Table 2.

Table 2—Elongation Requirements (PSL-2)

Yield strength		Elongation, minimum %	
MPa	(ksi)	$L_0 = 4d$ [a]	$L_0 = 5d$ [a]
Less than 310	(less than 45)	23	20
310 to 517	(45 to 75)	20	18
Over 517 to 758	(Over 75 to 110)	17	15
Over 758	(Over 110)	14	12

[a] Where L_0 is the gauge length and d is the diameter.

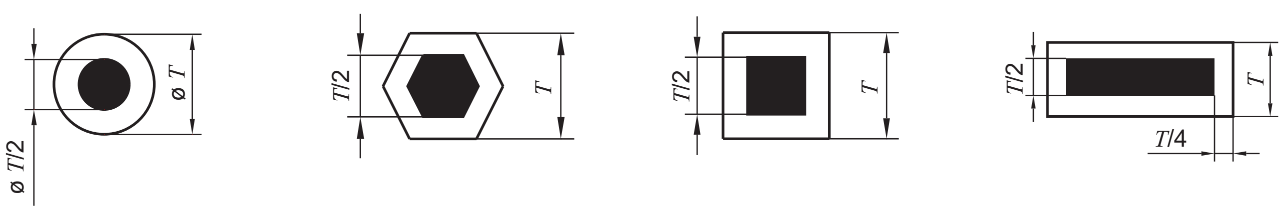
Table 3—Adjustment Factors for Sub-size Impact Specimens

Specimen dimensions mm	Adjustment factor
10.0 × 7.5	0.833
10.0 × 5.00	0.667

6.4 Material Qualification

6.4.1 Perform the mechanical tests 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 ASTM A370, or equivalent standards, using material in the final heat treated condition. For the purposes of material qualification testing, PWHT is not considered heat treatment, provided that the PWHT temperature is below that which changes the heat treatment condition of the base material.

6.4.2 Determine the size of the qualification test-coupon for a part using the equivalent round method. Figure 2 and Figure 3 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 5 and Figure 6 illustrate the procedure for determining the required dimensions of a keel block.



ER = T a) Round

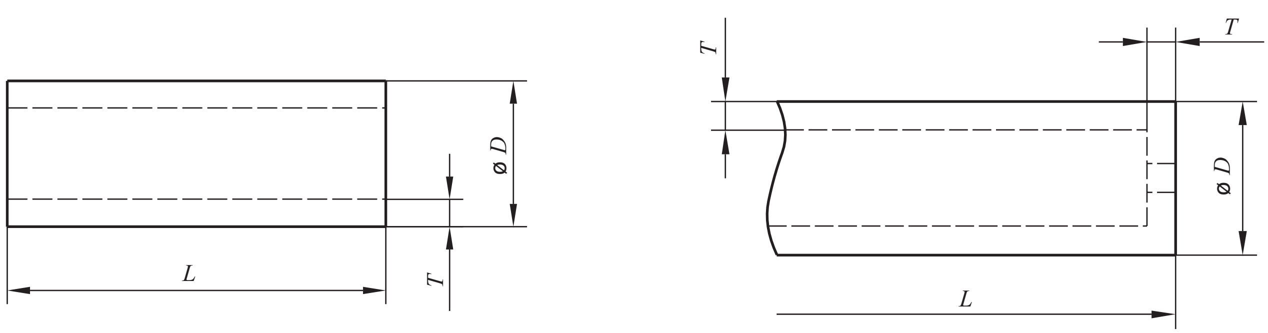
ER = 1.1T b) Hexagon

ER = 1.25T c) Square

ER = 1.5T d) Rectangle or plate

NOTE: If L is less than T, consider section as a plate of thickness L.

Figure 2—Equivalent Round Models, Solids of Length *L*



ER = 2T

NOTE: If L is less than D, consider as a plate of thickness T.

If L is less than T, consider as a plate of thickness L.

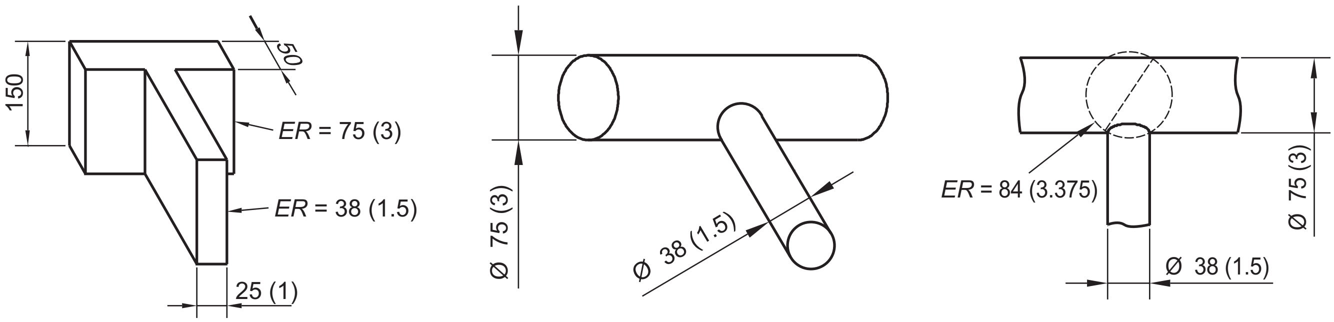
a) Open at both ends

ER = 2.5T if D is less than or equal to 63.5 mm (2.5 in.)
ER = 3.5T if D is greater than 63.5 mm (2.5 in.)

NOTE: Use maximum thickness, T, in the calculation.

b) Restricted or closed at one or both ends

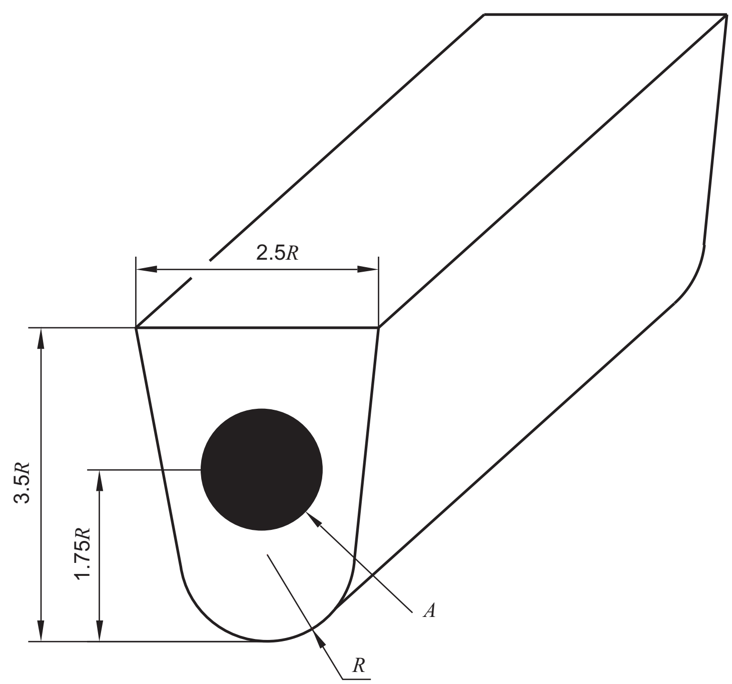
Figure 3—Equivalent Round Models, Tube (any Section)



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

NOTE 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.

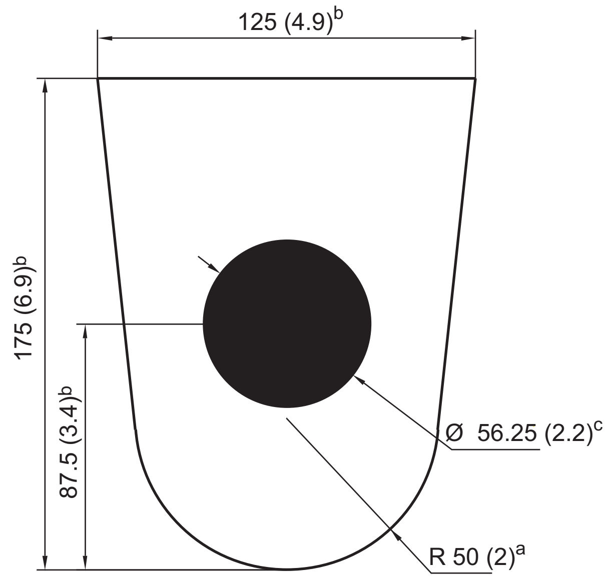
Figure 4—Equivalent Round Models, Complex Shape



ER = 2.3*R*

NOTE: Shaded area in *A* indicates 1/4*T* envelope for test specimen removal.

Figure 5—Equivalent Round Models, Keel Block Configuration



To develop a keel block for *ER* = 115 mm (4.5 in.), see footnotes below:

[a] Noting from Figure 5 that *ER* = 2.3*R*, then *R* = *ER*/2.3 = 50 mm (2 in.).

[b] Construct keel block as illustrated in Figure 5 using multiples of *R*.

[c] Diameter *D*.

Figure 6—Example of Development of Keel Block Dimensions

6.4.3 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.

6.4.4 Test specimens shall be removed from integral or separate qualification test-coupons so that their longitudinal centerline axis is entirely within the center 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 on a tensile specimen or the notch of an impact specimen shall be at least 1/4 thickness from the ends of the test-coupon.

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

6.4.6 For components to be machined entirely from wrought material that has been fully heat treated as a solid or tubular bar, whereby the standard 1/4 *T* envelope is either wholly or partly outside the volume of the critical and/or non-critical areas of the finished component, the test specimens, cut from the bar, may alternatively be taken from a more representative volume as defined by:

Volume OD defined by a 1/3 *T* envelope determined by using the maximum finished OD and the minimum finished ID of the final component.

The volume ID shall be equal to, or greater than, the minimum finished ID of the component.

EXAMPLE

150 mm (6.0 in.) OD 4330V bar, normalized quenched tempered (NQT);

Part final dimensions have maximum OD of 139.7 mm (5.5 in.), minimum ID of 63.5 mm (2.5 in.);

In SI units:

$T = (139.7 – 63.5)/2 = 38.1$ mm

$^1/_3\ T = 12.7$ mm;

In USC units:

$T = (5.5 – 2.5)/2 = 1.5$ in

$^1/_3\ T = 0.5$ in.;

The $^1/_3\ T$ envelope of the finished part would have a 114.3 mm (4.5 in.) OD;

Therefore, the specimens could be removed from anywhere within the volume defined by 114.3 mm (4.5 in.) OD × 63.5 mm (2.5 in.) ID; (the $^1/_3\ T$ outer envelope and the finished ID of the component).

6.5 Manufacture

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

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

6.5.3 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 treatment 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 may be consulted for guidance on the qualification of heat treatment equipment.

6.5.4 For PSL 2, the manufacturer shall specify the melting, refining, casting, and working practices for all components. The specified practices shall be recorded in the required written material specification.

6.6 Chemical Composition

The material composition of each heat shall be analyzed for all elements specified in the manufacturer's written material specification.

For PSL 2, the maximum mass fraction of sulfur and phosphorus shall each be 0.025, expressed as a percentage.

7 Welding Requirements

7.1 General

The remainder of this Section describes requirements for the fabrication and repair welding, where permitted, of primary-load-carrying components and pressure-containing components, including attachment welds.

7.2 Welding Qualifications

All welding undertaken on components shall be performed using welding procedures qualified in accordance with:

— PSL 1: ASME B31.3, ASME BPVC, Section IX, AWS D1.1, ISO 15614-1, and/or ASTM A488 or equivalent standards;

— PSL 2: ASME IX or equivalent standards.

This welding shall only be carried out by welders or welding operators who are qualified in accordance with the aforementioned standards or EN 287-1.

Welding procedures for base materials not listed in the above standards shall be qualified individually or as a group based on weldability, tensile properties or composition. If the parent metal is insufficiently ductile to meet the bend test requirements of ASME BPVC, Section IX, the bend test (for PSL 1 or PSL 2) 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 shall then be capable of being bent to within 5 degrees of the angle thus determined.

7.3 Written Documentation

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

The procedure qualification record shall record all essential and supplementary-essential (when required) variables of the welding procedure used for the qualification tests. Both the welding procedure specifications and the procedure qualification record shall be maintained as records in accordance with Section 11.

7.4 Control of Consumables

Welding consumables shall conform to the consumable-manufacturer's specifications. The manufacturer shall have a written procedure for storage and control of welding consumables.

Materials of low-hydrogen type shall be stored and used as recommended by the welding consumable manufacturer to retain their original low-hydrogen properties.

7.5 Weld Properties

The mechanical properties of the weld, as determined by the welding procedure qualification test, shall at least meet the minimum specified mechanical properties required by the design. If impact testing is required for the base material, it shall also be a welding procedure qualification requirement. Results of testing in the weld and HAZ shall meet the minimum requirements of the base material. For attachment welds, the HAZ of materials requiring impact testing, but not necessarily the weld, shall meet the above requirements.

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

For welded components with weld thicknesses greater than 25.4 mm (1 in.) that are not post-weld heat treated, a lowering of the impact test temperature should be considered by the manufacturer.

7.6 Post-weld heat treatment

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

7.7 Fabrication Welds

In addition to the requirements specified in 7.2 to 7.6, weld-joint types and sizes shall meet the manufacturer's design requirements and shall be documented in the manufacturer's welding procedure specification.

7.8 Repair Welds

7.8.1 Access

There shall be adequate access to evaluate, remove and inspect the non-conforming condition causing the need for the repair.

7.8.2 Fusion

The welding procedure specification and the available access for repair shall be such as to ensure complete fusion of the weld with the base material.

7.8.3 Forgings and Castings

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

Prior to any repair 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 Section 8.

For PSL 2, for major weld repairs as defined in 8.4.9.3, the manufacturer shall also produce a dimensional sketch of the area to be repaired and the repair sequence. Documentation of repairs shall be maintained in accordance with requirements of Section 11.

7.8.4 Tubulars

Repair welding on wrought tubular goods is not allowed.

7.8.5 Heat treatment

The welding procedure specification used for qualifying a repair shall reflect the actual sequence of weld repair and heat treatment performed on the repaired item.

8 Quality Control

8.1 General

This section 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 and quantitative and qualitative acceptance criteria.

Instructions for NDE activities shall be sufficiently detailed regarding the requirements of this Standard. All NDE instructions shall be approved by an ASNT SNT-TC-1A Level III examiner or an examiner qualified to an equivalent standard.

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 SNT-TC-1A or an equivalent standard.

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 program (if equivalent to the 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. MIL STD 120 [3] or ISO 10012-1 [1]), 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-carrying components and/or pressure-containing equipment and components unless specified otherwise.

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 be in accordance with 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 done no earlier than 24 h after the load test. The equipment shall be disassembled for this inspection. Conductive surface coatings shall be removed prior to examination. Non-conductive surface coating shall be removed prior to examination unless it has been demonstrated that the smallest relevant indications 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 BPVC, Secion V, Subsection A, Article 7, and Subsection B, Article 25 or ASTM E709. 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 BPVC, Secion V, Subsection A, Article 6, and Subsection B, Article 24 or ASTM E165.

If the use of prods cannot be avoided, all prod burn-marks shall be removed by grinding and the affected areas shall be 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 indications. 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 E125 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 4 for PSL 1 and Table 5 for PSL 2.

Table 4—PSL 1–Maximum Allowable Degrees for Discontinuities

Type	Maximum Allowable Degree		
	Discontinuity Descriptions	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

Table 5—PSL 2–Maximum Allowable Degrees for Discontinuities

Type	Maximum Allowable Degree		
	Discontinuity Descriptions	Critical Areas	Non-critical Areas
I	Hot tears, cracks	None	None
II	Shrinkage	None	Degree 1
III	Inclusions	Degree 1	Degree 2
IV	Internal chills, chaplets	None	Degree 1
V	Porosity	Degree 1	Degree 2

The manufacturer shall establish and maintain critical area drawings, identifying high-stress areas, which shall be used in conjunction with this section. For purposes of this section, critical areas shall be all areas where the stress in the component exceeds the value of:

$$\text{High Stress} \geq \frac{YS_{\text{min}}}{1.33\ SF_{\text{D}}} \tag{8}$$

where

YS_{min} is the specified minimum yield strength;

SF_{D} is the design safety factor.

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

Areas of components in which the stress is compressive, and/or where the stress level is less than the result of Equation (9), shall be exempt from the acceptance criteria defined in Table 4 and Table 5. The low stress areas, thus defined, may be identified on the critical area map.

$$\text{Low Stress} \leq \frac{0.1\ YS_{\text{min}}}{SF_{\text{D}}} \tag{9}$$

where

YS_{min} is the specified minimum yield strength;

SF_{D} is the design safety factor.

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 BPVC, Section V, Subsection A, Article 2, and Subsection B, Article 22 with the restriction that fluorescent intensifying screens shall not be used.

Ultrasonic examination shall be in accordance with ASME BPVC, Section V, Subsection A, Article 5, and Subsection B, Article 23. The component(s) shall be examined by the straight beam method in accordance with SA-609 of Subsection B, Article 23, supplemented by S1 angle beam examination requirements 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 degrees.

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

8.4.8.3.1 Volumetric Examination Exemptions

Areas of components in which the stress is compressive and/or where the stress level is less than the value of low stress (as calculated in 8.4.7.4) shall be exempt from volumetric examination.

8.4.8.3.2 Radiography

The acceptance criteria for radiographic examination are based on the standard reference radiographs of ASTM E446, ASTM E186, or ASTM E280 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 8.4.7.4. If critical areas are not identified on critical area drawings then all areas of the component shall be considered critical.

8.4.8.3.3 Ultrasonic Examination

The acceptance criteria for both straight beam and angle beam ultrasonic examination of castings are based on SA-609 in ASME BPVC, Section V, Subsection B, Article 23. The acceptance criteria shall be as follows:

a) PSL 1: Quality Level 3;

b) PSL 2:

   1) Quality Level 1 for casting thicknesses up to 50 mm (2 in.);

   2) Quality Level 2 for casting thicknesses from 50 mm (2 in.) to 100 mm (4 in.);

   3) Quality Level 3 for casting thicknesses over 100 mm (4 in.);

c) PSL 1 and PSL 2:

Regardless of casting thickness, Quality Level 1 shall apply within 50 mm (2 in.) of the casting surface.

Discontinuities indicated as having a change in depth of 25 mm (1 in.) or half the thickness, whichever is the lesser, are not permitted.

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 BPVC, Section V, Subsection 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 main load bearing 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-bearing and pressure-containing welds shall be examined by either ultrasonic or radiographic methods. Ultrasonic examination shall be in accordance with ASME BPVC Section V, Subsection A, Article 5, and radiographic examination shall be in accordance with ASME BPVC Section V, Subsection A, Article 2.

For PSL 1, this applies to full penetration welds only.

For PSL 2, this applies to all welds.

Acceptance criteria shall be in accordance with the requirements of ASME BPVC, 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).

For PSL 2, if the depth of repair exceeds 25 % of the original wall thickness, or 25.4 mm (1 in.) whichever is less, the repair shall be classed as major and shall also be examined by either radiography or ultrasonic methods. The methods and acceptance criteria shall be as defined for critical areas in 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).

For PSL 2, the verification of external interface dimensions shall be carried out on each component and/or assembly as relevant.

8.6 Proof Load Test

8.6.1 Extent

Each production unit of the following equipment shall be given a proof load test in accordance with 8.6.2:

a) elevators;

b) elevator links;

c) spiders (if capable of being used as elevators);

d) safety clamps (if capable of being used as hoisting equipment).

Equipment not listed above shall be given a proof load test if supplementary requirement SR-1 (see Annex A) is specified in the order.

8.6.2 Procedure

The equipment shall be mounted in a test fixture capable of loading the equipment in essentially the same manner as in actual service and with essentially the same areas of contact on the load-bearing surfaces.

A test load equal to 1.5 × the load rating shall be applied and held for a period of not less than 5 min.

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.

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

All critical areas of the primary-load-carrying components shall be subjected to magnetic particle examination in accordance with 8.4.7.

8.7 Hydrostatic Testing

8.7.1 General

If hydrostatic testing of equipment is required, as indicated in Section 9, the requirements of 8.7 shall apply.

8.7.2 Hydrostatic Testing

The hydrostatic test shall be carried out in the following four steps:

a) primary pressure-holding period;

b) reduction of the pressure to zero;

c) thorough drying of external surfaces of the equipment;

d) secondary pressure-holding period.

The timing of the secondary holding period shall not start until the test pressure has stabilized and the equipment and pressure-monitoring devices have been isolated from the pressure source.

Specific hydrostatic testing requirements are included under the relevant equipment headings of Section 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 Section 9.

8.9 Processes Requiring Validation

The following processes shall require validation when the specified properties of the final product cannot be verified after the process completion:

a) NDE;

b) welding;

c) heat treating;

d) bolt pretensioning (when a specific preload value is required by the design).

Where the properties required are specified in the design and production, and material qualification (e.g. material test reports, testing of qualification test coupons, etc.) is performed to verify that the required properties are achieved in each production heat/heat treatment lot, no further validation is required. Where a heat treatment process is specified, but the results are not verified by testing of each production heat/heat treatment lot of material subjected to the process(es), the process(es) shall be validated by testing of samples, which demonstrate that the process will consistently produce the properties required by the design. Validation method and results shall be documented.

9 Equipment

9.1 General

All the requirements of Section 4 through Section 8 apply to the primary-load-carrying components unless specifically noted otherwise in this section. It is the equipment designer's responsibility to determine the primary load path through the equipment and to define the primary-load-carrying components.

9.2 Hoisting Sheaves

9.2.1 Materials for Sheaves

Sheaves are exempt from impact testing.

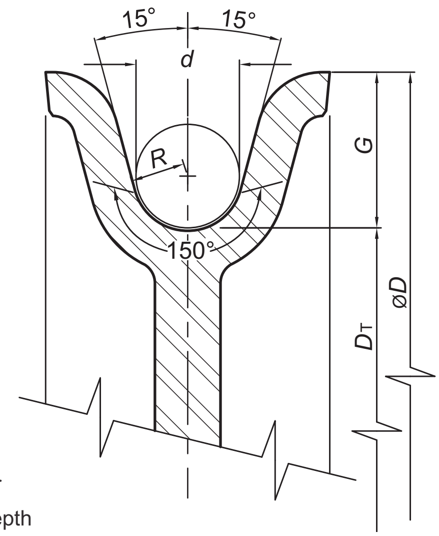
9.2.2 Sheave NDE

Surface-hardened areas of sheave grooves shall be exempt from the requirements of 8.4.7. NDE of the groove area may be performed prior to surface hardening the groove.

Sheave webs manufactured from rolled steel plate less than 50 mm (2 in.) thickness and having a specified minimum yield strength less than 310 MPa (45 ksi) shall be exempt from surface NDE.

9.2.3 Sheave Diameter

The sheave diameter shall be the overall diameter (D) shown in Figure 7. Sheave diameters shall, whenever practicable, be determined in accordance with API 9B.



Key

D_T = tread diameter

G = total groove depth

Figure 7—Sheave Grooves

9.2.4 Drilling and Casing Line Sheaves

Grooves for drilling and casing line sheaves shall be made for the selected rope size. The bottom of the groove shall have a radius, R, [see Equation (10) and Equation (11)] subtending an arc of 150 degrees. The sides of the groove shall be tangent to the ends of the bottom arc. Total groove depth, G, shall be a minimum of 1.33 d and a maximum of 1.75 d, where d is the nominal rope diameter shown in Figure 7.

9.2.5 Sand-line Sheaves

Grooves for sand-line sheaves shall be made for the selected rope size. The bottom of the groove shall have a radius of between R_{min} and R_{max} [see Equation (10) and Equation (11)] subtending an arc of 150 degrees. The sides of the groove shall be tangent to the ends of the bottom arc. Total groove depth, G, shall be a minimum of 1.75 d and a maximum of 3 d, where d is the nominal rope diameter shown in Figure 7.

NOTE API 9B gives details of sheave-groove gauging practice and data for worn sheaves.

$$R_{min} = R_{rope} \times 1.06 \tag{10}$$

$$R_{max} = R_{rope} \times 1.10 \tag{11}$$

where

R_{min} is the minimum new groove radius;

R_{max} is the maximum new groove radius;

R_{rope} is the nominal rope radius.

9.2.6 Marking

Sheaves shall be marked with the manufacturer's name or mark, the sheave groove size and the sheave outside diameter. These markings shall be cast or stamped on the side of the outer rim of the sheave.

EXAMPLE A 914 mm (36 in.) sheave with a 28.6 mm ($1^1/_8$ in.) groove manufactured by the AB Company is marked as follows:

AB CO 28.6 API Spec 8C 914or AB CO 1-1/8 API Spec 8C 36 or AB CO 1.125 API Spec 8C 36

9.3 Travelling Blocks

9.3.1 Sheaves

Travelling block sheaves shall comply with the applicable requirements of 9.2.

9.3.2 Sheave Bearing Rating

The bearing rating of travelling blocks shall be determined by the formula:

In SI units:

$$W_B = \frac{N \times W_R}{357} \tag{12}$$

In US Customary units:

$$\left(W_B = \frac{N \times W_R}{714}\right)$$

where

W_B is the calculated block bearing rating, expressed in kilonewtons (kN) (short tons);

N is the number of sheaves in the block;

W_R is the individual sheave bearing rating at 100 r/min for 3000 h minimum life for 90 % of bearings, expressed in newtons (N) (pounds force).

For anti-friction bearing design and manufacturing requirements, see 9.15.

9.3.3 Travelling Blocks

Contact-surface radii shall comply with the dimensions in Table 6 and Figure 8.

9.3.4 Hook Blocks

Contact-surface radii shall comply with the dimensions in Table 6 and Figure 8, Figure 9, and Figure 10. The method of connection between the travelling block component and the hook component shall be at the discretion of the manufacturer.

9.3.5 Travelling-block Hood-eye

The travelling-block hood-eye is a lifting eye located at the top of the travelling block and is used for lifting and hanging-off the weight of the travelling block and the attachments underneath. The load rating of the hood-eye shall be established with a minimum safety factor of 2.25. The load rating of the hood-eye shall be marked near the top handling member of the travelling block.

When verifying that the hood-eye can be used safely to lift or hang-off the travelling assembly, the mass of the travelling block shall be added to the mass of the attachments beneath.

9.3.6 Travelling Block Marking

Marking shall be in accordance with Section 10.

Table 6—Hoisting Tool Contact-Surface Radii

Load Rating		Traveling Block and Hook Bail Radius [a] mm (in.)				Hook and Swivel Bail Radius [b] mm (in.)			
kN	Short tons	A_1 max.	A_2 min.	B_1 min.	B_2 max.	E_1 min.	E_2 max.	F_1 max.	F_2 min.
222 to 356	25 to 40	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)	82.55 ($3^{1}/_{4}$)	76.20 (3)	50.80 (2)	38.10 ($1^{1}/_{2}$)	76.20 (3)	76.20 (3)
357 to 578	41 to 65	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)	82.55 ($3^{1}/_{4}$)	76.20 (3)	50.80 (2)	44.45 ($1^{3}/_{4}$)	88.90 ($3^{1}/_{2}$)	88.90 ($3^{1}/_{2}$)
579 to 890	66 to 100	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)	82.55 ($3^{1}/_{4}$)	76.20 (3)	57.15 ($2^{1}/_{4}$)	50.80 (2)	101.60 (4)	101.60 (4)
891 to 1334	101 to 150	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)	82.55 ($3^{1}/_{4}$)	76.20 (3)	63.50 ($2^{1}/_{2}$)	57.15 ($2^{1}/_{4}$)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
1335 to 2224	151 to 250	101.60 (4)	101.60 (4)	82.55 ($3^{1}/_{4}$)	76.20 (3)	69.85 ($2^{3}/_{4}$)	63.50 ($2^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
2225 to 3114	251 to 350	101.60 (4)	101.60 (4)	82.55 ($3^{1}/_{4}$)	76.20 (3)	76.20 (3)	69.85 ($2^{3}/_{4}$)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
3115 to 4448	351 to 500	101.60 (4)	101.60 (4)	88.90 ($3^{1}/_{2}$)	82.55 ($3^{1}/_{4}$)	88.90 ($3^{1}/_{2}$)	82.55 ($3^{1}/_{4}$)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
4449 to 5782	501 to 650	101.60 (4)	101.60 (4)	88.90 ($3^{1}/_{2}$)	82.55 ($3^{1}/_{4}$)	88.90 ($3^{1}/_{2}$)	82.55 ($3^{1}/_{4}$)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
5783 to 6672	651 to 750	152.40 (6)	152.40 (6)	88.90 ($3^{1}/_{2}$)	82.55 ($3^{1}/_{4}$)	107.95 ($4^{1}/_{4}$)	101.60 (4)	114.30 ($4^{1}/_{2}$)	114.30 ($4^{1}/_{2}$)
6673 to 11,120	751 to 1250	152.40 (6)	152.40 (6)	158.75 ($6^{1}/_{4}$)	152.40 (6)	133.35 ($5^{1}/_{4}$)	127.00 (5)	127.00 (5)	127.00 (5)
Load Rating		**Elevator Link Upper Eye and Hook Link Ear Radius [c] mm (in.)**				**Elevator Link Lower Eye and Elevator Link Ear Radius [c] mm (in.)**			
kN	**Short tons**	C_1 **max.**	C_2 **min.**	D_1 **min.**	D_2 **max.**	G_1 **max.**	G_2 **min.**	H_1 **min.**	H_2 **max.**
222 to 356	25 to 40	38.10 ($1^{1}/_{2}$)	38.10 ($1^{1}/_{4}$)	31.75 ($1^{1}/_{4}$)	22.23 ($^{7}/_{8}$)		25.40 (1)		50.80 (2)
357 to 578	41 to 65	63.50 ($2^{1}/_{2}$)	63.50 ($2^{1}/_{2}$)	31.75 ($1^{1}/_{4}$)	22.23 ($^{7}/_{8}$)		25.40 (1)		50.80 (2)
579 to 890	66 to 100	63.50 ($2^{1}/_{2}$)	63.50 ($2^{1}/_{2}$)	38.10 ($1^{1}/_{2}$)	28.58 ($1^{1}/_{8}$)		25.40 (1)		50.80 (2)
891 to 1 334	101 to 150	63.50 ($2^{1}/_{2}$)	63.50 ($2^{1}/_{2}$)	38.10 ($1^{1}/_{2}$)	28.58 ($1^{1}/_{8}$)	23.82 ($^{15}/_{16}$)	38.10 ($1^{1}/_{2}$)	50.80 (2)	50.80 (2)
1335 to 2224	151 to 250	101.60 (4)	101.60 (4)	44.45 ($1^{3}/_{4}$)	34.93 ($1^{3}/_{8}$)	30.94 ($1^{7}/_{32}$)	47.63 ($1^{7}/_{8}$)	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)
2225 to 3114	251 to 350	101.60 (4)	101.60 (4)	44.45 ($1^{3}/_{4}$)	34.93 ($1^{3}/_{8}$)	37.31 ($1^{15}/_{32}$)	47.63 ($1^{7}/_{8}$)	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)
3115 to 4448	351 to 500	101.60 (4)	120.65 ($4^{3}/_{4}$)	57.15 ($2^{1}/_{4}$)	47.63 ($1^{7}/_{8}$)	47.63 ($1^{7}/_{8}$)	50.80 (2)	82.55 ($3^{1}/_{4}$)	82.55 ($3^{1}/_{4}$)
4449 to 5782	501 to 650	101.60 (4)	120.65 ($4^{3}/_{4}$)	57.15 ($2^{1}/_{4}$)	47.63 ($1^{7}/_{8}$)	57.15 ($2^{1}/_{4}$)	60.32 ($2^{3}/_{8}$)	127.00 (5)	127.00 (5)
5783 to 6672	651 to 750	101.60 (4)	127.00 (5)	63.50 ($2^{1}/_{2}$)	63.50 ($2^{1}/_{2}$)	57.15 ($2^{1}/_{4}$)	60.32 ($2^{3}/_{8}$)	127.00 (5)	127.00 (5)
6673 to 11,120	751 to 1250	114.30 ($4^{1}/_{2}$)	127.00 (5)	76.20 (3)	69.85 ($2^{3}/_{4}$)	69.85 ($2^{3}/_{4}$)	73.03 ($2^{7}/_{8}$)	158.75 ($6^{1}/_{4}$)	158.75 ($6^{1}/_{4}$)

[a] See Figure 8.
[b] See Figure 9.
[c] See Figure 10.

9.4 Block-to-hook Adapters

Block-to-hook adapters shall have the same load rating as the hook.

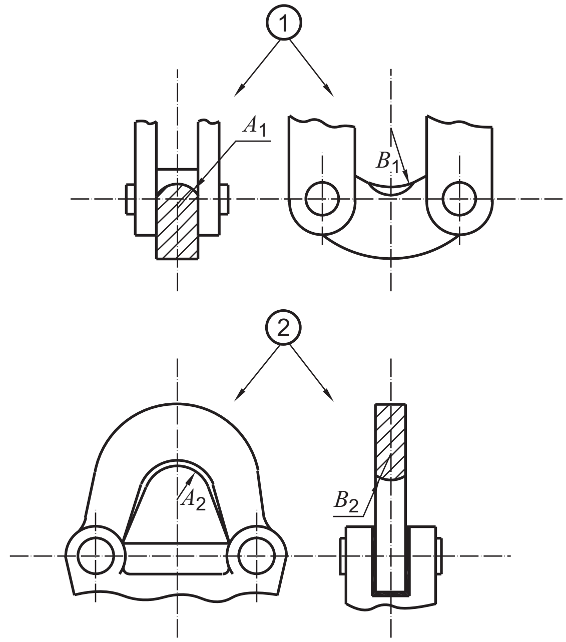
9.5 Connectors, Link Adapters, and Drill Pipe Elevator Adapters

The drill pipe elevator adapter shall be made to seat on a tapered or square-shouldered drill pipe elevator and shall have its elevator link ears designed to comply with the contact radii in Table 6 and Figure 10.

The contact radii of link adapters shall comply with the dimensions in Table 6 and Figure 8, Figure 9, and Figure 10.

9.6 Drilling Hooks

Contact surface radii of drilling hooks shall comply with the dimensions in Table 6 and Figure 8, Figure 9, and Figure 10.

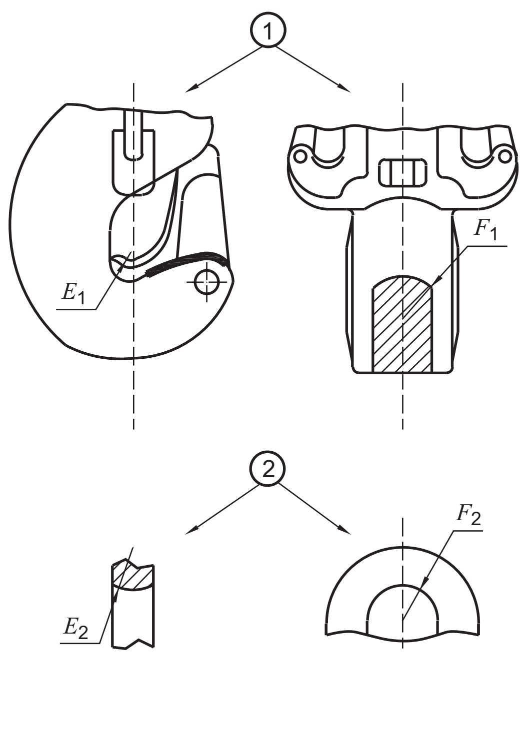


Key

1 travelling block becket

2 hook ball

Figure 8—Traveling Block and Hook Ball

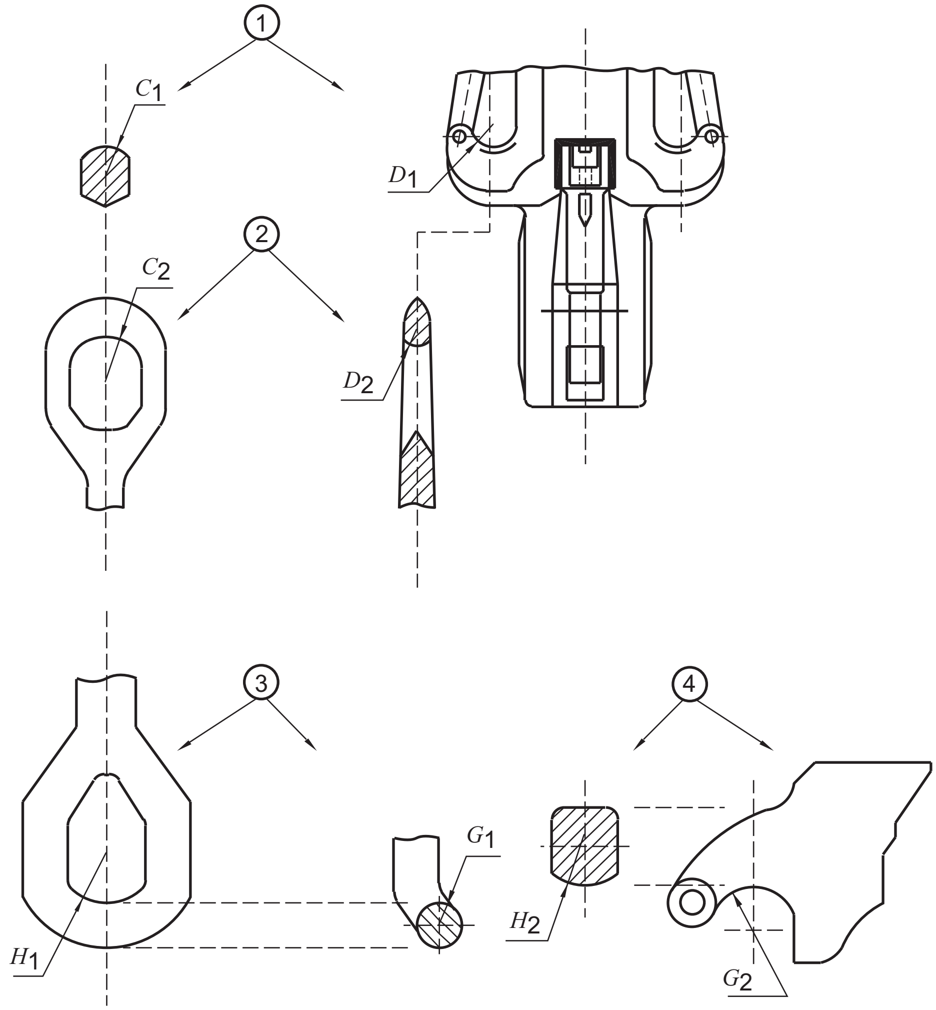


Key

1 hook

2 swivel ball

Figure 9—Hook and Swivel Ball Contact-Surface Radii



Key

1 hook link ear

2 elevator link upper eye

3 elevator link lower eye

4 elevator link ear

Figure 10—Elevator Link Eye and Hook Link Ear Contact-Surface Radii

9.7 Elevator Links

Elevator links shall comply with the dimensions in Table 6 and Figure 10.

Elevator links shall be designed and manufactured in pairs. Links up to and including 4.25 m (14 ft) in length (as measured between the contact surfaces) shall match within 4 mm ($^1/_8$ in.). Links over 4.25 m (14 ft) in length shall match within 7 mm ($^1/_4$ in.).

9.8 Elevators

9.8.1 Dimensions

Drill-pipe elevators for use with taper-shoulder tool joints and square-shoulder tool joints shall have bore dimensions as specified in Table 7.

Casing elevators and tubing elevators shall be suitable for use with casing and tubing manufactured in accordance with ISO 11960 or API 5CT and shall have bore dimensions as specified in Table 8 and Table 9 (see Figure 11).

NOTE The allowable tolerance on the outside diameter immediately behind the tubing upset may cause problems with slip-type elevators.

Table 7—Drill-pipe Elevator Bores and Markings

Tool- joint Designation Reference	Drill Pipe Size and Style (all weights and grades)	Tool Joints								Elevator Marking
		Taper Shoulder				Square Shoulder				
		Neck diameter D_{TE} max		Elevator bore		Neck diameter D_{SE} max		Elevator bore		
		mm	in.	mm	in.	mm	in	mm	in.	
NC 26 ($2^{3}/_{8}$ IF)	$2^{3}/_{8}$ EU	65.09	$2^{9}/_{16}$	67.47	$2^{21}/_{32}$		[a]		[a]	$2^{3}/_{8}$ EU
NC 31 ($2^{7}/_{8}$ IF)	$2^{7}/_{8}$ EU	80.96	$3^{3}/_{16}$	83.34	$3^{9}/_{32}$	80.96	$3^{3}/_{16}$	85.73	$3^{3}/_{8}$	$2^{7}/_{8}$ EU
NC 31	$3^{1}/_{2}$ IU	93.66[b]	3-11/16[b]	96.04[b]	$3^{25}/_{32}$[b]	[a]	[a]	[a]	[a]	$3^{1}/_{2}$ IU
NC 38 ($3^{1}/_{2}$ IF)	$3^{1}/_{2}$ EU	98.43	$3^{7}/_{8}$	100.81	$3^{31}/_{32}$	98.43	$3^{7}/_{8}$	103.19	$4^{1}/_{16}$	$3^{1}/_{2}$ EU
NC 40 (4FH)	$3^{1}/_{2}$ EU	98.43	$3^{7}/_{8}$	100.81	$3^{31}/_{32}$	98.43	$3^{7}/_{8}$	103.19	$4^{1}/_{16}$	
NC 40 (4 FH)	4 IU	106.36	$4^{3}/_{16}$	108.74	$4^{9}/_{32}$	104.78	$4^{1}/_{8}$	109.54	$4^{5}/_{16}$	4 IU
NC 46 (4 IF)	4 EU	114.30	$4^{1}/_{2}$	121.44	$4^{25}/_{32}$	114.30	$4^{1}/_{2}$	122.24	$4^{13}/_{16}$	
NC 46 (4 IF)	$4^{1}/_{2}$ IU	119.06	$4^{11}/_{16}$	121.44	$4^{25}/_{32}$	117.48	$4^{5}/_{8}$	122.24	$4^{13}/_{16}$	4 EU, or
NC 46 (4 IF)	$4^{1}/_{2}$ IEU	119.06	$4^{11}/_{16}$	121.44	$4^{25}/_{32}$	117.48	$4^{5}/_{8}$	122.24	$4^{13}/_{16}$	$4^{1}/_{2}$ IU,
$4^{1}/_{2}$ FH	$4^{1}/_{2}$ IU	119.06	$4^{11}/_{16}$	121.44	$4^{25}/_{32}$	117.48	$4^{5}/_{8}$	122.24	$4^{13}/_{16}$	or
$4^{1}/_{2}$ FH	$4^{1}/_{2}$ IEU	119.06	$4^{11}/_{16}$	121.44	$4^{25}/_{32}$	117.48	$4^{5}/_{8}$	122.24	$4^{13}/_{16}$	$4^{1}/_{2}$ IEU
NC 50 ($4^{1}/_{2}$ IF)	$4^{1}/_{2}$ EU	127.00	5	133.35	$5^{1}/_{4}$	127.00	5	134.94	$5^{5}/_{16}$	$4^{1}/_{2}$ EU,
NC 50 ($4^{1}/_{2}$ IF)	5 IEU	130.18	$5^{1}/_{8}$	133.35	$5^{1}/_{4}$	130.18	$5^{1}/_{8}$	134.94	$5^{5}/_{16}$	or
$5^{1}/_{2}$ FH	5 IEU	130.18	$5^{1}/_{8}$	133.35	$5^{1}/_{4}$	130.18	$5^{1}/_{8}$	134.94	$5^{5}/_{16}$	5 IEU
$5^{1}/_{2}$ FH	$5^{1}/_{2}$ IEU	144.46	$5^{11}/_{16}$	147.64	$5^{13}/_{16}$	144.46	$5^{11}/_{16}$	149.23	$5^{7}/_{8}$	$5^{1}/_{2}$ IEU
$6^{5}/_{8}$ FH	$6^{5}/_{8}$ IEU	176.21	$6^{15}/_{16}$	178.59	$7^{1}/_{32}$	[a]	[a]	[a]	[a]	$6^{5}/_{8}$ IEU

Tolerances: Bore: $^{+0.80}_{\ \ 0}$ mm ($^{+1/32}_{\ \ 0}$ in.) Taper: $^{+2°}_{\ 0}$

NOTE Elevators with the same bores are the same elevators.

[a] Not manufactured.

[b] Denotes dimensions that are commonly used that are not covered by API 5DP.

9.8.2 Drill Pipe Elevator Marking

In addition to the markings specified in 10.2, drill-pipe elevators shall be marked designating drill-pipe size and style from Table 7.

9.8.3 Slip-type Elevators and Slip-type Spiders

9.8.3.1 Design verification testing of slip-type elevators and slip-type spiders shall be carried out with the slips/ inserts in place. Production-load testing may be carried out without the slips/inserts installed, using a tapered mandrel designed to simulate the actual loading conditions.

Table 8—Elevator Bores for Non-upset Casing and Tubing

Nominal Casing or Tubing Size D	Formula for New Top Bore T_B [a,b] (see Figure 11)
$D < 4^1/_2$ in.	$1.001 \times (D \times 25.4) + 1.88$ mm ($1.001 \times D + 0.074$ in.)
$4^1/_2$ in. $\le D < 9^5/_8$ in.	$1.0125 \times (D \times 25.4) + 1.22$ mm ($1.0125 \times D + 0.048$ in.)
$9^5/_8$ in. $\le D < 12^7/_8$ in.	$1.0125 \times (D \times 25.4) + 0.89$ mm ($1.0125 \times D + 0.035$ in.)
$12^7/_8$ in. $\le D \le 20$ in.	$1.0125 \times (D \times 25.4) + 0.56$ mm ($1.0125 \times D + 0.022$ in.)
20 in. $< D < 42$ in.	$1.010 \times (D \times 25.4) + 1.90$ mm ($1.010 \times D + 0.075$ in.)
42 in. $\le D$	$1.010 \times (D \times 25.4) + 3.18$ mm ($1.010 \times D + 0.125$ in.)

Tolerances:

$T_B \le 254$ mm	$\pm$ 0.40 mm	$B_B \le 254$	$^{+0.80}_{-0.40}$ mm
($T_B \le 10$ in.	$\pm$ $^1/64$ in)	($B_B \le 10$	$^{+1/32}_{-1/64}$ in.)
254 mm $< T_B \le 508$	$^{+0.80}_{-0.40}$ mm	254 mm $< B_B \le 508$	$^{+1.60}_{-0.40}$ mm
(10 in. $< T_B \le 20$	$^{+1/32}_{-1/64}$ in)	(10 in. $< B_B \le 20$	$^{+1/16}_{-1/64}$ in.)
$T_B > 508$	$^{+1.60}_{-0.80}$ mm	$B_B > 508$	$^{+1.60}_{-0.80}$ mm
($T_B > 20$	$^{+1/16}_{-1/32}$ in.)	($B_B > 20$	$^{+1/16}_{-1/32}$ in.)

NOTE 1 Refer to Figure 11 for the relationship of T_B and B_B.

NOTE 2 Longitudinal, circumferential or spiral welds should be ground flush in the area of slip or elevator contact.

NOTE 3 Bore sizes take in account a casing tolerance of +1 %/ –0.5 % on the casing outside diameter. If the casing diameter including the circumferential weld is within the standard tolerance, these bores can be used. If the bottom bore may interfere with circumferential, longitudinal, or spiral welds, consideration should be given to grinding flush in the area of possible slip contact or elevator contact.

NOTE 4 See API 8B, Annex A, for maximum allowable wear for square shouldered elevator bores in-service.

[a] Bottom bore B_B is optional; some elevator designs do not have a bottom bore.

[b] New bottom bore, B_B may be the same at manufacturer's option.

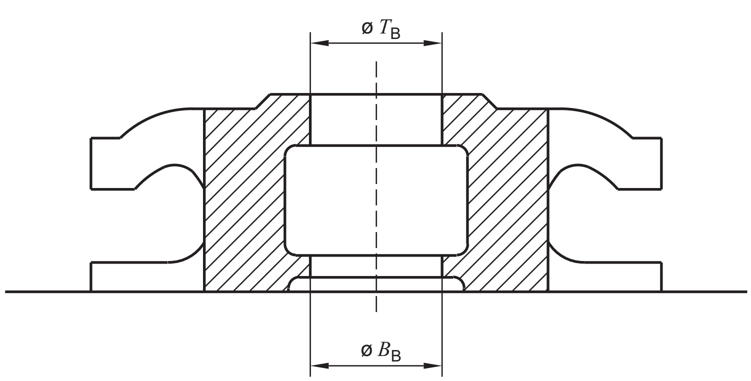


Figure 11—Casing and Tubing Elevator Bores

Table 9—Elevator Bores for Upset Tubing

Tubing	External-upset Tubing							
	Collar diameter		Upset diameter		Top bore T_B		Bottom bore[a] B_B	
Nominal Size	mm	in.	mm	in.	mm	in.	mm	in.
1.050	42.16	1.660	33.40	1.315	36.12	1.422	36.12	1.422
1.315	48.26	1.900	37.31	1.469	40.08	1.578	40.08	1.578
1.660	55.88	2.200	46.02	1.812	48.82	1.922	48.82	1.922
1.900	63.50	2.500	53.19	2.094	55.96	2.203	55.96	2.203
$2^3/8$	77.80	3.063	65.89	2.594	68.66	2.703	68.66	2.703
$2^7/8$	93.17	3.668	78.59	3.094	81.36	3.203	81.36	3.203
$3^1/2$	114.30	4.500	95.25	3.750	98.02	3.859	98.02	3.859
4	127.00	5.000	107.95	4.250	110.72	4.359	110.72	4.359
$4^1/2$	141.30	5.563	120.65	4.750	123.42	4.859	123.42	4.859

CAUTION Do not use external-upset tubing elevators on non-upset tubing.

Tolerances:

Top bore (T_B): ± 0.40 mm (± $^1/_{64}$ in.)

Bottom bore (B_B): $^{+0.80}_{-0.40}$ mm ($^{+1/32}_{-1/64}$ in.)

NOTE Refer to Figure 11 for the relationship of T_B and B_B.

[a] Bottom bore, B_B, is optional. some elevator designs do not have a bottom bore.

9.8.3.2 The slips' activating mechanism shall be functionally tested on each production unit, demonstrating full compliance with design requirements.

9.8.3.3 Inserts are exempt from mechanical testing and traceability requirements.

9.8.3.4 Primary load-carrying components of elevators shall meet the impact testing requirements of 8.4.4. Elevator slips shall be made from materials possessing a minimum impact toughness (average of three tests) of 20 J (15 ft-lb) with no individual value less than 14 J (10 ft-lb) at a maximum test temperature of –20 °C (–4 °F).

9.8.3.5 The manufacturer of the equipment shall provide, in the documentation delivered with the equipment (see 11.3c), frequency of inspection and acceptance criteria for NDE of slip-type elevator setting rings.

9.8.3.6 Proof load testing, as described in 8.6, shall apply. Additionally, the following shall apply:

a) replacement hinge pins and latch pins shall meet or exceed the original manufacturer's specifications;

b) replacement hinge pins or latch pins manufactured from wrought material are exempt from proof load testing requirements.

9.9 Rotary Swivels

9.9.1 Swivel Bearing-load Rating

The bearing-load rating of swivels shall be determined by Equation (13):

In SI units:

$$W_{\mathrm{S}} = \frac{W_{\mathrm{R}}}{800} \tag{13}$$

In US Customary units:

$$W_{\mathrm{S}} = \frac{W_{\mathrm{R}}}{1600}$$

where

W_{S} is the calculated main bearing thrust rating at 100 r/min, expressed in kilonewtons (kN) (short tons);

W_{R} is the main bearing thrust rating at 100 r/min for 3000 h minimum life for 90 % of bearings, expressed in newtons (N) (pounds force).

For anti-friction bearing design and manufacturing requirements, see 9.15.

9.9.2 Rotary Swivel Prototype Pressure Testing

The assembled test unit shall be statically pressure-tested.

The test pressure shall be twice the working pressure for working pressures up to and including 34.5 MPa (5000 psi). For working pressures above 34.5 MPa (5000 psi), the test pressure shall be at least 1.5 times the working pressure, but not less than 69 MPa (10,000 psi). The test pressure shall be held for two cycles of 3 min each in accordance with the pressure/time sequence specified in 9.9.3.

9.9.3 Production Pressure-testing

The cast components of the rotary-swivel hydraulic circuit shall be pressure-tested in production. The production test-pressure shall be shown on the cast member.

The hydrostatic pressure-test shall consist of the following four steps:

a) primary pressure-holding period;

b) reduction of the pressure to zero;

c) thorough drying of all external surfaces of the components;

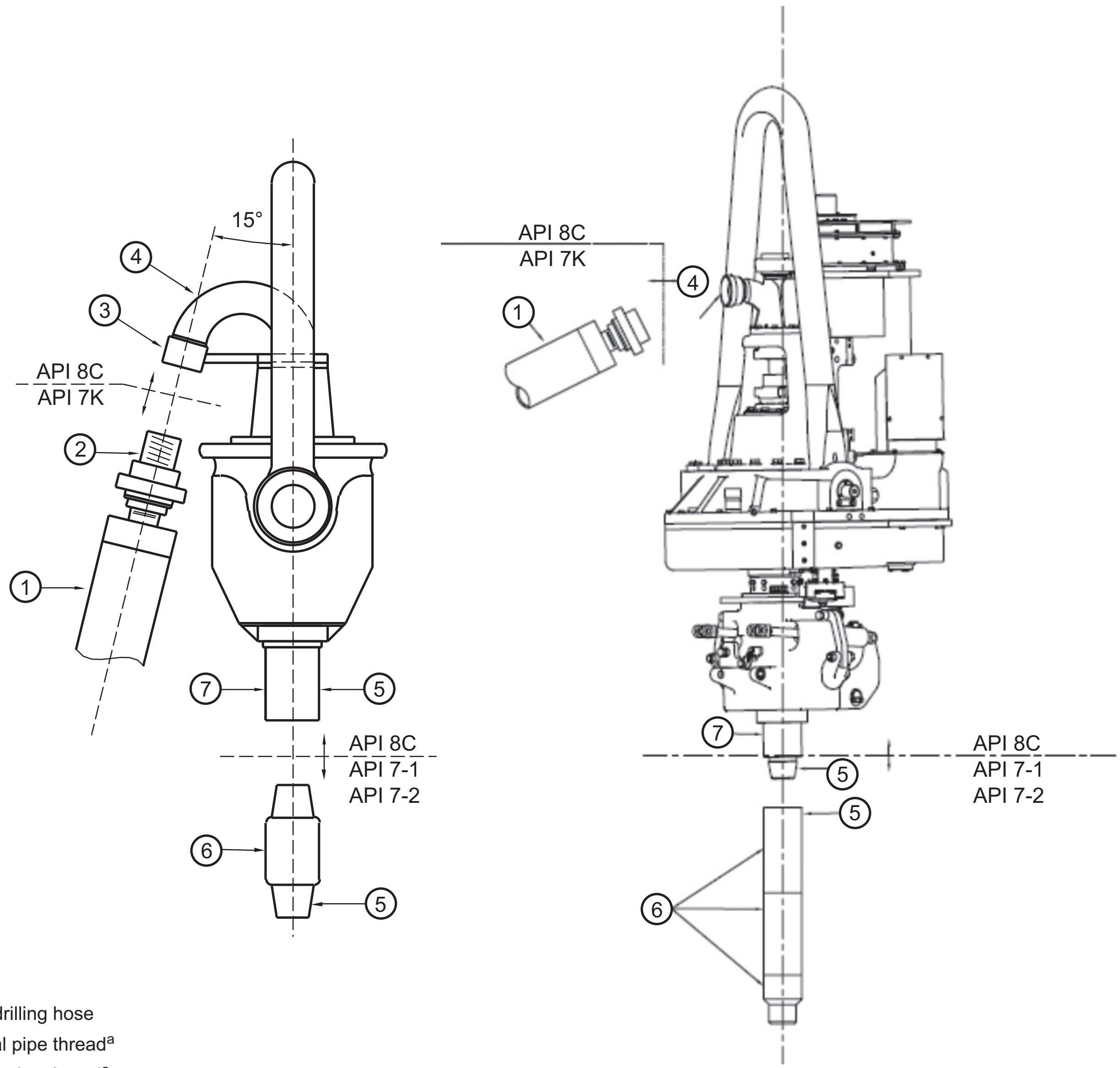
d) secondary pressure-holding period.

The production test pressure shall be equal to the prototype test pressure, as defined in 9.9.2. The pressure-holding periods shall be not less than 3 min, the timing of which shall not start until the test pressure has been reached and the equipment and pressure-monitoring device have been isolated from the pressure source. During this period, no detectable pressure drop or leakage shall be allowed.

9.9.4 Swivel gooseneck connection

9.9.4.1 Dimensions

The angle between the gooseneck centerline and the vertical shall be 15 degrees. The connection size and type shall be agreed by the purchaser and manufacturer and specified on the purchase order (see Figure 12).



Key

1 rotary drilling hose

2 external pipe thread[a]

3 internal pipe thread[a]

4 gooseneck

5 API standard rotary connection LH

6 miscellaneous drill stem components

7 swivel stem[a]

[a]Other connections may be used, see 9.9.4.1

Figure 12—Rotary Swivel Connections

9.9.4.2 Threads

If gooseneck connections are threaded, the threads shall comply with API 5B.

Nominal size threads shall be marked with the size and type of thread.

See Section 10 for further marking requirements.

9.9.5 Rotary-shouldered Connections

All rotary swivel and power swivel sub connections shall comply with the applicable requirements, including gauging and marking, as specified in API 7-1 and API 7-2. For rotary shouldered connections used in hoisting (non-drill stem) applications see 4.3.8.

9.9.6 Rotary Hose Safety Attachment

Rotary hose gooseneck or S-pipe connections shall be provided with a safety connection lug containing a 28.6 mm ($1^1/8$ in.) diameter hole for attaching a safety chain or wire rope sling. The lug shall be designed to accommodate a safety chain or wire rope sling, as specified in API 7K. The lug and its supporting structure shall have a minimum breaking strength of 71.1 kN (16,000 lb) when used with hoses of 101.6 mm (4 in.) internal diameter or less and a minimum breaking strength of 142.3 kN (32,000 lb) when used with hoses of internal diameter greater than 101.6 mm (4 in.).

9.9.7 Swivel Washpipes

Swivel washpipes shall be exempt from the impact requirements of Section 6 and the NDE requirement of Section 8.

9.10 Power Swivels

A power swivel is a device which moves with the travelling block and is designed to provide rotary power to the top of the drill string for drilling operations. It replaces the rotary swivel and includes a rotary seal and bearing for supporting the drill-string weight.

The bearing-load rating shall be calculated using Equation (13) in 9.9.1.

Pressure testing shall be in accordance with 9.9.2 and 9.9.3.

Power-swivel gooseneck and sub connections, and rotary-hose safety-chain attachments shall be in accordance with 9.9.4.2, 9.9.5, and 9.9.6.

9.11 Power Subs

9.11.1 General

A power sub is a device which moves with the travelling block and is designed to provide rotary power to the top of the drill string for drilling operations. It attaches to the bottom of the rotary swivel, but does not include a rotary seal or bearing for supporting the drill-string weight.

9.11.2 Power Sub Gooseneck Extension

Power sub gooseneck extensions shall meet the thread and marking requirements of 9.9.4. If a gooseneck extension is used which causes the rotary-hose safety-chain attachment on the rotary swivel to be in an inconvenient location, an additional attachment lug shall be provided. This attachment lug shall meet the requirement of 9.9.6.

9.11.3 Power Sub Connections

Both the upper and lower power sub connections shall meet the requirements of 9.9.5.

9.12 Wireline Anchors

Wireline anchors shall be classed by the rated line pull, in kilonewtons (kN) (Kips).

The load rating of wireline anchors shall be determined as outlined in 4.6 except that the design safety factor shall be determined as given in Table 10.

Table 10—Load Rating of Wireline Anchors

Load Rating R	**Design Safety Factor** SF_D
$R \leq 178$ kN (40 Kips)	3.00
178 kN (40 Kips) $< R \leq 445$ kN (100 Kips)	$3.00 - 0.75\,(R - 178)/267$ [a] $3.00 - 0.75\,(R - 40)/60$ [b]
$R > 445$ kN (100 Kips)	2.25

[a] In this formula the value of R shall be in kilonewtons.

[b] In this formula the value of R shall be in Kips.

9.13 Drill-string Motion Compensators

Drill-string motion compensators, either travelling or top-mounted, shall comply with Section 9. Traveling drill-string motion compensators' contact-surface radii shall comply with the dimensions given in Table 6 and Figure 8.

9.14 Pressure Vessels and Piping

Pressure vessels and piping forming part of the equipment shall be manufactured in accordance with a recognized code or standard.

9.15 Anti-friction Bearings

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

9.16 Safety Clamps Capable of being used as Hoisting Equipment

9.16.1 Inserts

Inserts shall be exempt from mechanical testing and traceability requirements.

9.16.2 Clamp Make-up Torque

Manufacturers shall state the minimum and maximum make-up torque for the clamp to achieve the load rating.

9.16.3 Lifting Lugs

Manufacturers shall state the minimum number of lifting lugs for each maximum load rating.

9.17 Guide Dollies

9.17.1 General

The purpose of the guide dolly is to hold the travelling equipment in the correct position relative to the derrick during the various operations and to react drilling torque. A retractable dolly shall also be able to move the travelling equipment horizontally between the drilling position and the retracted position.

According to the definition in 3.1.12, the dolly is not a primary-load-carrying component, because the primary load will not pass through it. Still as a consequence of the functions described above, the dolly will be subjected to considerable forces. The requirements of Section 4 through Section 8 apply unless specifically noted otherwise in this section.

9.17.2 Design

9.17.2.1 Rating

Dollies are not load rated.

9.17.2.2 Design Safety Factor

Guide dollies are exempt from the design safety factors as specified in 4.7. Design safety factors for guide dollies shall be applied as defined in 9.17.2.3.

9.17.2.3 Principal Loading Conditions and Corresponding Safety Factors

9.17.2.3.1 Members and cross sections, including hydraulic cylinders and connected equipment, shall be designed for the most unfavorable of the following three PLCs using the associated design safety factors according to Table 11.

9.17.2.3.2 The loads and load combinations to be considered in each of the PLCs defined in 9.17.2.4 shall be as specified in 9.17.2.4.1, 9.17.2.4.2, and 9.17.2.4.3.

Table 11—Design Safety Factors

PLC No.	Description of Condition	Safety Factor
I	Equipment working without environmental loads	1.5
II	Equipment working with environmental loads	1.33
III	Exceptional loads	1.1

9.17.2.4 Loads and Load Combinations

9.17.2.4.1 In PLC I, the following load combinations (LC) shall be considered:

a) LC I, 1: drilling

This includes the effect of weight of the travelling equipment and dolly, and the drilling torque generated by the travelling equipment.

b) LC I, 2: braking

This includes the effect of the weight of the travelling equipment, including the dolly, multiplied by a minimum factor of 2.

c) LC I, 3: retraction/extension

This LC applies to retractable dollies only, and shall at least cover acceleration/retardation in the extended position and in the retracted position. Simultaneous effects of weight and possible vertical accelerations shall be included.

d) LC I, 4: horizontal pull

If normal operations can involve a horizontal force component acting on the travelling equipment, this shall be considered together with the effects of weight.

9.17.2.4.2 In PLC II, the four load combinations defined in 9.17.4.1 shall be considered together with appropriate "operating environmental conditions". For a fixed platform (or land rig), this will include only wind, acting in the most unfavorable direction. For a floating platform (or drill ship), the effects of heel, trim and platform movements shall also be considered.

9.17.2.4.3 In PLC III, the following load combinations shall be considered:

a) LC III, 1: exceptional vertical accelerations;

These are jarring or drill string failure. The load combination will be the effect of the weight of the travelling equipment, including the dolly, multiplied by a minimum factor of 4.

b) LC III, 2: exceptional environmental conditions;

This load combination shall, in addition to the weight, include environmental loads having a 100 year return period. For a fixed platform, the environmental load will be only wind.

c) LC III, 3: accidental heel;

This situation is relevant only in the case of a floating platform (or drill ship). A static heel of at least 35° shall be taken into account.

d) LC III, 4: setback conditions.

This load condition is due to the weight of the travelling equipment supported by the guide dolly. This condition normally occurs during installation or maintenance of the travelling equipment when the entire weight of the travelling equipment and dolly may be supported by a guide rail stop.

9.17.2.5 Special Safety Precautions

The hydraulic system of a retractable dolly shall be equipped with the necessary devices to control the maximum active and passive oil pressures and the acceleration of the travelling equipment.

The manufacturer shall prepare a maintenance and operation manual in accordance with 11.3.

9.17.3 Design Verification Test

Guide Dollies shall be exempt from design verification testing.

9.17.4 Materials Requirements

Exempt from the requirements of Section 6.

9.17.5 Quality Control

Surface NDE (welds only) – All welds shall be inspected using magnetic particle (MP) or liquid penetrate (LP) method in accordance with of AWS D1.1.

Volumetric NDE (welds only) – All full or partial penetration welds loaded in tension to 70 % or greater of their allowable stress, as determined by design, shall be ultrasonic or radiograph inspected in accordance with AWS D1.1.

9.17.6 Marking

Guide dollies are exempt from the requirements in 10.2.

10 Marking

10.1 Product Marking

Each item of hoisting equipment shall be marked with “API Spec 8C”, the manufacturer's name or mark, the relevant PSL number and the rating specified in 10.2. Additional markings shall be applied in accordance with Section 9 and 10.4. Equipment for which supplementary requirements apply shall be marked with the relevant “SR” numbers.

10.2 Rating Marking

Each item of hoisting equipment shall be marked with load rating/pressure rating.

EXAMPLE A PSL 1 travelling block with a load rating of 8000 kN (899 short tons), manufactured by the AB Company is marked as follows:

AB CO 899 ton API Spec 8C PSL 1

10.3 Composite Equipment Marking

For assemblies having multi-purpose attachments such as tubing blocks, hook-block combination, etc., each unit shall be marked separately with its load rating.

10.4 Component Traceability

Primary-load-carrying components and pressure-containing components shall be uniquely marked as specified in 8.4.5, unless specifically stated otherwise.

10.5 Serialization

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

10.6 Marking Method

Marking referred to in 10.1 to 10.3 and 10.5 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 high ($^3/_8$ in.) where the physical dimensions of the component will permit.

11 Documentation

11.1 General

Full records of the documentation specified in Section 11 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, and loss.

All quality records shall be signed and dated. Computer-sorted records shall contain the originator's personal code.

The manufacturer shall make available all records and documentation for examination by the purchaser, or his agents, to demonstrate compliance with this Standard.

11.2 Documentation to be kept by the Manufacturer

The following documentation shall be kept by the manufacturer:

a) design documentation (see 4.11);

b) design verification documentation (see 5.8);

c) written specifications (see Sections 6, 7, and 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,

— hardness tests.

— NDE records covering the surface and/or volumetric NDE requirements of Section 6;

— performance test records including:

— proof load test records,

— hydrostatic pressure testing records,

— functional testing records,

— special process records.

Special process records include actual heat treatment time/temperature charts and weld repair records as specified in Section 5. 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.

11.3 Documentation to be Delivered with the Equipment

A comprehensive data book may be specified by supplementary requirement SR 3 (see Annex A) in the purchase order, otherwise, 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 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 and critical-area drawings;
- list of components;
- nominal capacities and ratings;
- operating procedures;
- wear limits, including elevator bore wear limits (see API 8B, Table A.1, for method of computing and limitations on wear limits);
- recommended frequency of field inspection and preventive maintenance, methods and acceptance criteria;
- dropped object prevention guidelines;
- itemized spare parts (not applicable to single-component equipment) and recommended stock levels;
- for PSL 2, capacity changes as a result of wear.

Annex A
(normative)

Supplementary Requirements

A.1 General

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

A.2 SR 1 Proof Load Test

The equipment shall be given a proof load test and subsequently examined in accordance with 8.6.2.

The equipment shall be marked “SR 1” using low-stress, hard die-stamps near the load rating identification. Marking “SR 1” is not required on equipment for which proof load testing is normally required under Section 8 or Section 9.

A.3 SR 2 Low Temperature Test

The maximum impact test temperature for materials used in primary-load-carrying components with a required minimum operating temperature below –20 °C (–4 °F) shall be specified by the purchaser.

Impact testing shall be performed in accordance with 6.3 and ASTM A370. 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).

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

A.4 SR 3 Data Book

If specified by the purchaser, records shall be prepared, gathered and properly collated by the manufacturer into a data book. The data book for each unit shall include at least the following:

— statement of compliance;

— equipment designation/serial number[9];

— wear limits and nominal capacities and ratings[9];

— list of components;

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

— steel grades;

— heat treatment records[9];

— material test reports[9];

— NDE records;

[9] Equipment as listed in Section 1 with exception of r).

— performance test records including functional hydrostatic and load testing certificates (when applicable);

— supplementary requirements certificates as required;

— welding procedure specifications and qualification records.

A.5 SR 4 Additional Volumetric Examination of Castings

The requirements for SR 4 shall be identical to the requirements of 8.4.8, except that all critical areas of each primary-load-carrying casting shall be examined.

A.6 SR 5 Volumetric Examination of Wrought Material

The entire volume of primary-load-carrying wrought components shall be examined by the ultrasonic method. If 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 A388 (the immersion method may be used) and ASTM E428. Straight-beam calibration shall be performed using a distance-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 amplitude curve and located within 13 mm ($^1/_2$ in.) of one another, are not allowed.

A.7 SR 6 Boreback Stress-relief Feature

When requested by the purchaser, the boreback box stress-relief feature shall be a supplementary requirement for 9.9.5, 9.10, and 9.11.3. The connection shall conform to the applicable requirements as specified in API 7-1 and API 7-2 for the drill collar boreback box stress-relief feature.

Annex B
(informative)

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 (±25 °F) 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 (±25 °F) 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 treatment of production parts shall be performed with heat treatment 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

These 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 greater than 0.29 m^3 (10 ft^3). For rectangular furnaces, one of the nine thermocouple test locations shall be placed near 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 degrees apart as shown in Figure B.1.

c) For each 3.54 m^3 (125 ft^3) of furnace working zone surveyed, at least one thermocouple test location shall be used, up to a maximum of 60 thermocouples. The additional thermocouples shall be distributed within the working zone of the furnace.

d) For furnaces having a working zone less than 0.29 m^3 (10 ft^3), the temperature survey maybe 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 temperature has reached the set-point temperature, the temperature of all test locations shall be recorded at two-minute intervals maximum, for at least 10 min. Then, readings shall be taken at five-minute intervals maximum for sufficient time to determine the recurrent temperature pattern of the furnace working zone for at least 30 min.

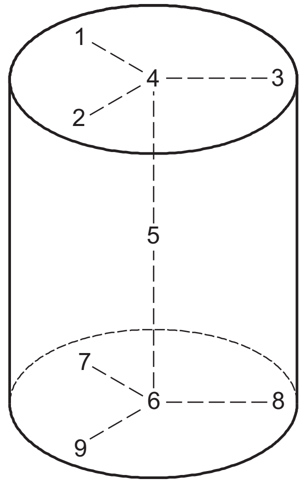


Figure B.1—Thermocouple Locations in Cylindrical Furnaces

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 (25 °F).

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.

B.2.4 Continuous-type Furnace Method

Continuous heat treatment 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)

API Monogram

C.1 Scope

The API Monogram Program allows an API Licensee to apply the API Monogram to products. The API Monogram Program delivers significant value to the international oil and gas industry by linking the verification of an organization's quality management system with the demonstrated ability to meet specific product specification requirements. The use of the Monogram on products constitutes a representation and warranty by the Licensee to purchasers of the products that, on the date indicated, the products were produced in accordance with a verified quality management system and in accordance with an API product specification.

When used in conjunction with the requirements of the API License Agreement, API Specification Q1, in its entirety, defines the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products in accordance with an API product specification.

API Monogram Program licenses are issued only after an on-site audit has verified that the Licensee conforms to the requirements described in API Specification Q1 in total, and the requirements of an API product specification. Customers/users are requested to report to API all problems with API monogrammed products. The effectiveness of the API Monogram Program can be strengthened by customers/users reporting problems encountered with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at https://ncr.api.org. API solicits information on new product that is found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements.

This annex sets forth the API Monogram Program requirements necessary for a supplier to consistently produce products in accordance with API specified requirements. For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, D.C. 20005 or call 202-962-4791 or by email at certification@api.org.

C.2 References

In addition to the referenced standards listed earlier in this document, this annex references the following standard:

API Specification Q1.

For Licensees under the Monogram Program, the latest version of this document shall be used. The requirements identified therein are mandatory.

C.3 API Monogram Program: Licensee Responsibilities

C.3.1 Maintaining a License to use the API Monogram

For all organizations desiring to acquire and maintain a license to use the API Monogram, conformance with the following shall be required at all times:

a) the quality management system requirements of API Q1,

b) the API Monogram Program requirements of API Q1, Annex A,

c) the requirements contained in the API product specification(s) for which the organization desires to be licensed,

d) the requirements contained in the API Monogram Program License Agreement.

C.3.2 Monogrammed Product—Conformance with API Q1

When an API-licensed organization is providing an API monogrammed product, conformance with API specified requirements, described in API Q1, including Annex A, is required.

C.3.3 Application of the API Monogram

Each Licensee shall control the application of the API Monogram in accordance with the following.

a) Each Licensee shall develop and maintain an API Monogram marking procedure that documents the marking / monogramming requirements specified by the API product specification to be used for application of the API Monogram by the Licensee. The marking procedure shall define the location(s) where the Licensee shall apply the API Monogram and require that the Licensee's license number and date of manufacture be marked on monogrammed products in conjunction with the API Monogram. At a minimum, the date of manufacture shall be two digits representing the month and two digits representing the year (e.g. 05-07 for May 2007) unless otherwise stipulated in the applicable API product specification. Where there are no API product specification marking requirements, the Licensee shall define the location(s) where this information is applied.

b) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the Licensee's API Monogram marking procedure if the product is subsequently found to be nonconforming with API specified requirements. Products that do not conform to API specified requirements shall not bear the API Monogram.

c) Only an API Licensee may apply the API Monogram and its license number to API monogrammable products. For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. The current API requirements for Monogram marking are detailed in the API Policy Document, Monogram Marking Requirements, available on the API Monogram Program website at http://www.api.org/certifications/monogram/.

d) The API Monogram shall be applied at the licensed facility.

e) The authority responsible for applying and removing the API Monogram shall be defined in the Licensee's API Monogram marking procedure.

C.3.4 Records

Records required by API product specifications shall be retained for a minimum of five years or for the period of time specified within the product specification if greater than five years. Records specified to demonstrate achievement of the effective operation of the quality system shall be maintained for a minimum of five years.

C.3.5 Quality Program Changes

Any proposed change to the Licensee's quality program to a degree requiring changes to the quality manual shall be submitted to API for acceptance prior to incorporation into the Licensee's quality program.

C.3.6 Use of the API Monogram in Advertising

Licensee shall not use the API Monogram on letterheads or in any advertising (including company-sponsored web sites) without an express statement of fact describing the scope of Licensee's authorization (license number). The Licensee should contact API for guidance on the use of the API Monogram other than on products.

C.4 Marking Requirements for Products

C.4.1 General

These marking requirements apply only to those API Licensees wishing to mark their products with the API Monogram.

C.4.2 Product Specification Identification

Manufacturers shall mark equipment with the information identified in Section 10, as a minimum, including “API Spec 8C.”

C.4.3 Use of U.S. Customary Units

As a minimum, equipment should be marked with U.S. Customary Units (USC). The use of dual units (USC and SI) is acceptable.

C.4.4 License Number

The API Monogram license number shall not be used unless it is marked in conjunction with the API Monogram.

C.5 API Monogram Program: API Responsibilities

The API shall maintain records of reported problems encountered with API monogrammed products. Documented cases of nonconformity with API specified requirements may be reason for an audit of the Licensee involved, (also known as audit for “cause”).

Documented cases of specification deficiencies shall be reported, without reference to Licensees, customers or users, to API Subcommittee 18 (Quality) and to the applicable API Standards Subcommittee for corrective actions.

Bibliography

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

[2] FEM [10], *Rules for the design of hoisting appliances.*

[3] MILSTD 120 [11], *Gage inspection.*

[4] ASTM A668, *Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.*

[5] ASTM A781, *Standard Specification for Castings, Steel and Alloy, Common Requirements for General Industrial Use.*

[6] ASTM A788, *Standard Specification for Steel Forgings, General Requirements.*

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

[8] API Recommended Practice 8B, Recommended Practice for Procedures for Inspections, Maintenance, Repair, and Remanufacture of Hoisting Equipment.

[10] Fédération Européenne de la Manutention, 39-41 rue Louis Blanc, 92400 Courbevoie, 92038 Paris, la Defense Cedex, France.
[11] Department of Defense, Pentagon, Washington DC, 20301, USA.

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