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

API SPECIFICATION 8C
THIRD EDITION, DECEMBER 1997

EFFECTIVE DATE: MAY 1998

American
Petroleum
Institute

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FOREWORD

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The purpose of this specification is to establish higher product specification levels for hoisting equipment to meet the requirements of users and regulatory bodies.

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

1 Scope

1.1 PURPOSE

The purpose of this specification is to provide standards for design, manufacture, and testing of hoisting equipment suitable for use in drilling and production operations.

1.2 EQUIPMENT COVERED

This specification covers the following drilling and production hoisting equipment:

a. Crown block sheaves and bearings.
b. Traveling blocks and hook blocks.
c. Block to hook adapters.
d. Connectors and link adapters.
e. Drilling hooks.
f. Tubing and sucker rod hooks.
g. Elevator links.
h. Casing, tubing, drill pipe, and drill collar elevators.
i. Sucker rod elevators.
j. Rotary swivel bail adapters.
k. Rotary swivels.
l. Power swivels.
m. Power subs.
n. Spiders, when capable of being used as elevators.
o. Wireline anchors.
p. Drill string motion compensators.
q. Kelly spinners when capable of being used as hoisting equipment.
r. Pressure vessels and piping mounted onto hoisting equipment.
s. Safety clamps, when capable of use as lifting devices.

Note: See Appendix D for guidance on design of guide dollies.

1.3 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

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

1.4 PRODUCT SPECIFICATION LEVELS

This specification establishes requirements for two product specification levels. These two PSL designations define different levels of technical requirements. PSL 1 includes practices currently being implemented by a broad spectrum of the manufacturing industry. All the requirements of Sections 1 through 11 of this specification are applicable to PSL 1 unless specifically identified as PSL 2. PSL 2 includes all the requirements of PSL 1 plus additional practices currently being implemented by a broad spectrum of users.

1.5 SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall apply only when specified by the purchaser in the contract or order. Appendix A gives a number of standardized supplementary requirements.

1.6 METRIC CONVERSION

Metric conversions of SI units are provided in parentheses throughout the text of this specification, e.g., 6 inches (152.4 millimeters). Metric conversions of SI units are also included in all tables and figures. The factors used for conversion of Imperial units to metric values are given in Appendix B.

2 Referenced Standards

This specification includes by reference, either in total or in part, other API and industry standards. The edition effective at the date of purchase order or date of manufacture, whichever is earliest, shall apply.

Requirements of other standards included by reference in this specification are essential to the safety and interchangeability of the equipment produced.

Other nationally or internationally recognized standards may be used provided it can be shown that they meet or exceed the requirements of the referenced standards herein.

Note: Only those standards listed below are considered part of this specification. Documents (subtier) that are referenced by those standards are not considered part of this specification.

AS 1260 *Equivalent Sections of Certain Shapes to Round Bars*
BS 5781 *Measurement and Calibration Systems*
FEM *Rules for the Design of Hoisting Appliances*

API
Spec 4F *Specification for Drilling and Well Servicing Structures*
Std 5B *Specification for Threading, Gauging and Thread Inspection of Casing, Tubing, and Line Pipe Threads*
Spec 5CT *Specification for Casing and Tubing*
Spec 7 *Specification for Rotary Drilling Equipment*
RP 9B *Recommended Practice on Application, Care and Use of Wire Rope for Oil Field Service*

ASME[1]

B31.3	*Chemical Plant and Petroleum Refinery Piping*
Section V	"Non-Destructive Examination"
Section VIII	"Pressure Vessel Code"
Section IX	"Welding and Brazing Qualifications"

ASNT[2]

TC-1A	*Recommended Practice for Personnel Qualification and Certification in Non-Destructive Testing*

ASTM[3]

A370	*Standard Test Methods and Definitions for Mechanical Testing of Steel Products*
A488	*Recommended Practice for Qualification of Procedures and Personnel for the Welding of Steel Castings*
A668	*Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use*
A770	*Specification for Through Thickness Tension Testing of Steel Plates for Special Applications*
A781	*Specification for Steel and Alloy Castings for General Industrial Use*
A788	*Specification for Steel Forgings, General Requirements*
E4	*Load Verification of Testing Machines*
E125	*Reference Photographs for Magnetic Particle Indications on Ferrous Castings*
E165	*Practice for Liquid Penetrant Inspection Method*
E186	*Reference Radiographs for Heavy-Walled [2 to 4$^1/_2$ Inches (51 to 114 Millimeters)] Steel Castings*
E280	*Reference Radiographs for Heavy-Walled [4$^1/_2$ to 12 Inches (114 to 305 Millimeters)] Steel Castings*
E446	*Reference Radiographs for Steel Castings Up to 2 Inches (51 Millimeters) in Thickness*
E709	*Practice for Magnetic Particle Examination*

AWS[4]

D1.1	Structural Welding Code

MIL

MIL-H-6875F	*Heat Treatment of Steels, Aircraft Practice Process*
MIL STD 120	*Gauge Inspection*

MSS[5]

MSS SP-55	*Quality Standard for Steel Castings—Visual Method*

3 Definitions

3.1 bearing load rating: A calculated maximum load bearing rating for bearings subject to the primary load.

3.2 design load: The static plus dynamic load that would cause the maximum allowable stress in the item.

3.3 design safety factor: A safety factor to account for a certain safety margin between maximum allowable stress and the minimum specified yield strength of the material used.

3.4 design verification test: A test undertaken to validate the integrity of the design calculations used.

3.5 dynamic load: The load applied to the equipment due to acceleration effects.

3.6 equivalent round: A standard for comparing various shaped sections to round bars, in determining the response to hardening characteristics when heat treating low-alloy and martensitic corrosion-resistant steels.

3.7 maximum allowable stress: The specified minimum yield stress divided by the design safety factor.

3.8 may: Within this specification, *may* is used to indicate a provision is optional.

3.9 primary load: The axial load to which the equipment is subjected in operations.

3.10 primary load carrying components: Those components of the covered equipment through which the primary load is carried.

3.11 product specification level: The level of material and process controls placed upon the primary load carrying components of the covered equipment.

3.12 proof load test: A production load test undertaken to validate the load rating of the unit.

3.13 rated load: The maximum operating load, both static and dynamic, to be applied to the covered equipment. The rated load is numerically equivalent to the design load.

3.14 repair: The removal of defects from castings or fabrication welds and refurbishment of the component or assembly by welding during the manufacturing process. Note that

[1]American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.
[2]American Society of Nondestructive Testing,
[3]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959.
[4]American Welding Society, 550 LeJeune Road, N.W., P.O. Box 351040, Miami, Florida 33135.
[5]Manufacturers Standardization Society of the Valve Industry, Inc., 127 Park Street, N.E. Vienna, VA 22180

repair as referred to in this specification applies only to the manufacture of new equipment.

3.15 safe working load: The safe working load is equal to the design load reduced by the dynamic load.

3.16 shall: Within this specification, *shall* is used to indicate a provision is mandatory.

3.17 should: Within this specification, *should* is used to indicate a provision is not mandatory but is recommended as good practice.

3.18 size class: Represents the dimensional interchangeability and the maximum rated load of equipment specified herein.

3.19 special process: An operation that may change or affect the mechanical properties, including toughness, of the material sued in the equipment.

3.20 test unit: A prototype unit upon which a design verification test is conducted.

4 Design

4.1 DESIGN CONDITIONS

The following design conditions shall apply:

a. The design load and the safe working load shall be as defined in Section 3. The operator of the equipment shall be responsible for determination of the safe working load for any hoisting operation.

b. The minimum design and operating temperature is –4°F (–20°C), unless changed by a supplementary requirement.

CAUTION: Use of the equipment covered by this specification at rated loads and temperatures less than –4°F (–20°C) is not recommended unless appropriate materials with the required toughness properties at lower design temperatures have been used for the equipment. (See Appendix A, SR 2.)

4.2 STRENGTH ANALYSIS

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

The strength analysis shall be based on the elastic theory. The nominal equivalent stress according to Von Mises-Hencky Theory caused by the design load shall not exceed the maximum allowable stress defined below. The equivalent stress shall be defined as follows:

$$\sigma_e = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1\sigma_2 - \sigma_2\sigma_3 - \sigma_1\sigma_3}$$

or

$$\sigma_e = \frac{(\sqrt{2})}{2}\sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_1 - \sigma_2)^2}$$

Where:

σ_e = the flow stress in tension and σ_1, σ_2, and σ_3 are the true principal stresses in combined loading. Equivalent forms of these equations are acceptable. For biaxial stress states, σ_3 is zero.

$$\text{Maximum Allowable Stress} = \frac{\text{Specified Yield Strength}}{\text{Design Safety Factor}}$$

Note: Faupel, J.H. and Fisher, F.E., Engineering Design, 2nd Edition, 1981, p. 389.

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

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

4.2.4 The use of empirical relationships are permitted in lieu of analysis, provided such relationships are documented with strain gauge testing to verify the stresses within the part. Equipment or components that by their design do not permit attachment of strain gauges to verify the design shall be qualified by testing in accordance with Section 5.5.

4.2.5 An ultimate strength (plastic) analysis is permitted under either of the following conditions:

a. Contact areas.

b. Areas of highly localized stress concentrations due to part geometry, and other areas of high stress gradient where the average stress in the section is less than or equal to the maximum allowable stress as defined in Section 4.2.1.

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

In case of plastic analysis the equivalent stress as defined in 4.2.1 shall not exceed the maximum allowable stress defined as follows:

$$\text{Maximum Allowable Stress} = \frac{\text{Specified Ultimate Strength}}{\text{Design Safety Factor}}$$

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

4.2.7 The fatigue analysis shall be based on a period of time of not less than 20 years.

4.2.8 The fatigue analysis shall be carried out according to generally accepted theories. A method that may be used is defined in the FEM *Rules for the Design of Hoisting Appliances.*

4.3 SIZE CLASS DESIGNATION

The size class designation shall represent the dimensional interchangeability and the rated load of equipment specified herein. The recommended size classes are as follows:

Short Tons	Metric Tons
5	4.5
10	9.1
15	13.6
25	22.7
40	36.3
65	59
100	91
150	136
250	227
350	318
500	454
650	590
750	681
1000	908

4.4 CONTACT SURFACE RADII

Figures 6, 7, and 8 and Table 9 show radii of hoisting tool contact surfaces. These recommendations cover hosting tools used in drilling (tubing hooks are included), but all other work-over tools are excluded.

4.5 RATING

4.5.1 All hoisting equipment furnished under this specification shall be rated in accordance with the requirements specified herein.

4.5.2 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.

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

4.6 LOAD RATING BASES

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

4.7 DESIGN SAFETY FACTOR

4.7.1 Design safety factor shall be established as follows:

Load Rating		
Tons	Metric Tons	Design Safety Factor, SF_D
150 and less	136 and less	3.00
150 to 500	136 to 454	$3.00 - \frac{0.75(R-150)}{350}$
500 and over	454 and over	2.25

Where:

R = load rating in tons.

Note: Where R = load rating in metric tons, the formula is

$$300 - \frac{0.75(R-136)}{318}$$

4.7.2 Load Rating shall be marked on the equipment.

4.7.3 Use the following equation to determine maximum allowable stress:

$$\text{Maximum Allowable Stress} = \frac{\text{Specified Minimum Yield Stress}}{\text{Design Safety Factor}}$$

The maximum working stress associated with the design load is ≤ maximum allowable stress.

CAUTION: Design safety factor is intended as design criteria and shall not under any circumstances be construed as allowing loads on the equipment in excess of those established under this specification.

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 SPECIFIC EQUIPMENT

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

4.10 DESIGN DOCUMENTATION

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

The requirements also apply to design change documentation.

5 Design Verification Testing

5.1 DESIGN VERIFICATION TESTING

To assure the integrity of equipment design, design verification testing shall be performed as described below.

Design verification testing of equipment designed and built to this specification shall be carried out and/or certified by a department or organization independent of the design function. Design verification testing conducted prior to the first issue of this specification per the requirements of API Specification 8A, Eleventh Edition, are considered to meet the requirements of this specification. However, the sampling requirements of Sections 5.2 and 5.5 shall apply.

Equipment, which by virtue of its simple geometric form permits accurate stress analysis through calculations only, shall be exempted from design verification testing (e.g., traveling blocks).

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

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

5.3 TEST PROCEDURES

5.3.1 The test unit shall be loaded to the design load. After this load has been released, the unit shall be checked for design functions. The design functioning of all equipment parts shall not be impaired by this loading.

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

5.3.3 The design verification test load to be applied to the test unit shall be determined as follows: design verification test load = 0.8 x R x SF_D, but not less than 2R, where R is the maximum load rating in tons and SF_D is the design safety factor as defined in Sections 3 and 4.7.

5.3.4 The unit shall be loaded 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 may be loaded as many times as necessary to obtain adequate data.

5.3.5 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 Section 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.

5.3.6 Upon completion of the design verification test, the unit shall be disassembled and the dimensions of each part checked for evidence of yielding.

5.3.7 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

The load rating shall be determined from the results of the design verification testing and/or design and stress distribution calculations required by Section 5.1. The stresses at that rating shall not exceed the values allowed in Section 4.2. Localized yielding shall be permitted at areas of contact. In a unit that has been design verification tested, the critical permanent deformation determined by strain gauges or other suitable means shall not exceed 0.2 percent except in contact areas. If the stresses exceed the allowable value, the affected part or parts must be redesigned to obtain the desired rating. Stress distribution calculations may be used to load rate equipment only if the analysis has shown to be within acceptable engineering allowances as verified by the design verification testing prescribed by this section.

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 tested and determining the yield to ultimate strength ratio. The ratio is then used to rate the equipment by the following equation:

$$R = L_b \times \frac{YS_a}{TS_a} \times \frac{YS_m}{YS_a \times SF_D}$$

Where:

SF_D = Design safety factor (see Section 4.7).
YS_a = Actual yield strength, psi.
YS_m = Minimum specified yield strength, psi.
TS_a = Actual ultimate tensile strength, psi.
L_b = Breaking load, tons.
R = Load rating, tons.

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

5.6 DESIGN VERIFICATION TESTING APPARATUS

The loading apparatus used to simulate the working load on the test unit shall be calibrated in accordance with ASTM E4 so as to ensure that the prescribed test load is obtained. For loads exceeding 400 tons (363 metric tons) the load testing apparatus may be verified with calibration devices traceable to a Class A calibration device and having an uncertainty of less than 2.5 percent.

Test fixtures shall load the 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 unit (or part) shall be verified as to its capability to perform the test.

5.7 DESIGN CHANGES

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

5.8 RECORDS

All design verification records and supporting data shall be subject to the same controls as specified for design documentation in Section 11.1.

6 Materials Requirements

6.1 GENERAL

All materials used in the manufacture of equipment furnished under this specification shall be suitable for the intended service.

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

6.2 WRITTEN SPECIFICATIONS

Materials shall be produced to a written material specification.

For PSL 2, the written specified requirements shall, as a minimum, define the following parameters and limitations:

a. Mechanical property requirements.
b. Material qualifications.
c. Processing requirements, including permitted melting, working, and heat treatment practices.
d. Chemical composition and tolerances.
e. Repair welding requirements.

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

6.3 MECHANICAL PROPERTIES

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

Components with a specified minimum yield strength of at least 45,000 psi (310 mPa) shall be from materials possessing a minimum impact toughness of 31 foot-pounds (42 joules) at –4°F (–20°C). The specified minimum shall be an average of three tests, with no individual value less than 24 foot-pounds (32 joules), using full size test pieces where possible. For components with a minimum specified yield strength of less than 45,000 psi (310 mPa), the –4°F (–20°C) minimum impact toughness shall be 20 foot-pounds (27 joules) with no individual value less than 15 foot-pounds (20 joules).

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

For design temperatures below –20°C (e.g., Arctic service) supplementary impact toughness requirements shall apply. See Appendix A, Supplementary Requirement SR 2.

Where the design requires through thickness properties, materials shall be tested for reduction of area in the thickness direction according to ASTM A770. The minimum reduction shall be 25 percent.

For PSL 2, components shall be fabricated from materials meeting the applicable requirements for ductility specified in Table 2 of this specification.

Table 1—Adjustment Factors for Subsize Impact Specimens

Specimen Dimensions mm × mm	Adjustment Factor
10.0 × 7.5	0.833
10.0 × 5.0	0.667

Table 2—Elongation Requirements

Yield Strength		Elongation Minimum Percent L_o = Gauge Length; d = Diameter	
psi	mPa	$L_o = 4d$	$L_o = 5d$
Less than 45,000	Less than 310	23	20
45,000 to 75,000	310 to 517	20	19
75,001 to 110,000	517.1 to 758	17	15
Over 110,000	Over 758	14	12

6.4 MATERIAL QUALIFICATION

The mechanical tests required by this specification shall be performed on qualification test coupons representing the heat and heat treatment lot used in the manufacture of the component. Tests shall be performed in accordance with the requirements of ASTM A370, or equivalent standards, using material in the final heat treated condition. For the purposes of material qualification testing, stress relief following welding is not considered heat treatment. Material qualification Tests may be performed before the stress relieving process, provided that the stress relieving temperature is below that which changes the heat treatment condition.

The size of the qualification test coupon for a part shall be determined using the equivalent round (ER) method. Figure 1 illustrates the basic models for determining the ER of simple solid and hollowed parts. Any of the shapes shown may be used for the qualification test coupon. Figure 2 shows the steps for determining the governing ER for more complex sections. The ER of a part shall be determined using the actual dimensions of the part in the "as heat treated" condition. The ER of the qualification test coupon shall be equal to or greater than the equivalent round dimensions of the part it qualifies, except that the ER is not required to exceed 5 inches. Figure 3 illustrates the procedure for determining the required dimensions of an ASTM A370 keel block.

Qualification test coupons may be integral with the components they represent or separate from the components or a sacrificial production part. In all cases, test coupons shall be from the same heat as the components they qualify, given the same working operations, and shall be heat treated with the components.

Test specimens shall be removed from integral or separate qualification test coupons such that their longitudinal center line axis is wholly within the center core $^1/_4$ thickness envelope for a solid test coupon or within $^1/_8$ inch (3 millimeters) 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.

Test specimens taken from sacrificial production parts shall be removed from the center core $^1/_4$ thickness envelope location of the thickest section of the part.

6.5 MANUFACTURE

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

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

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

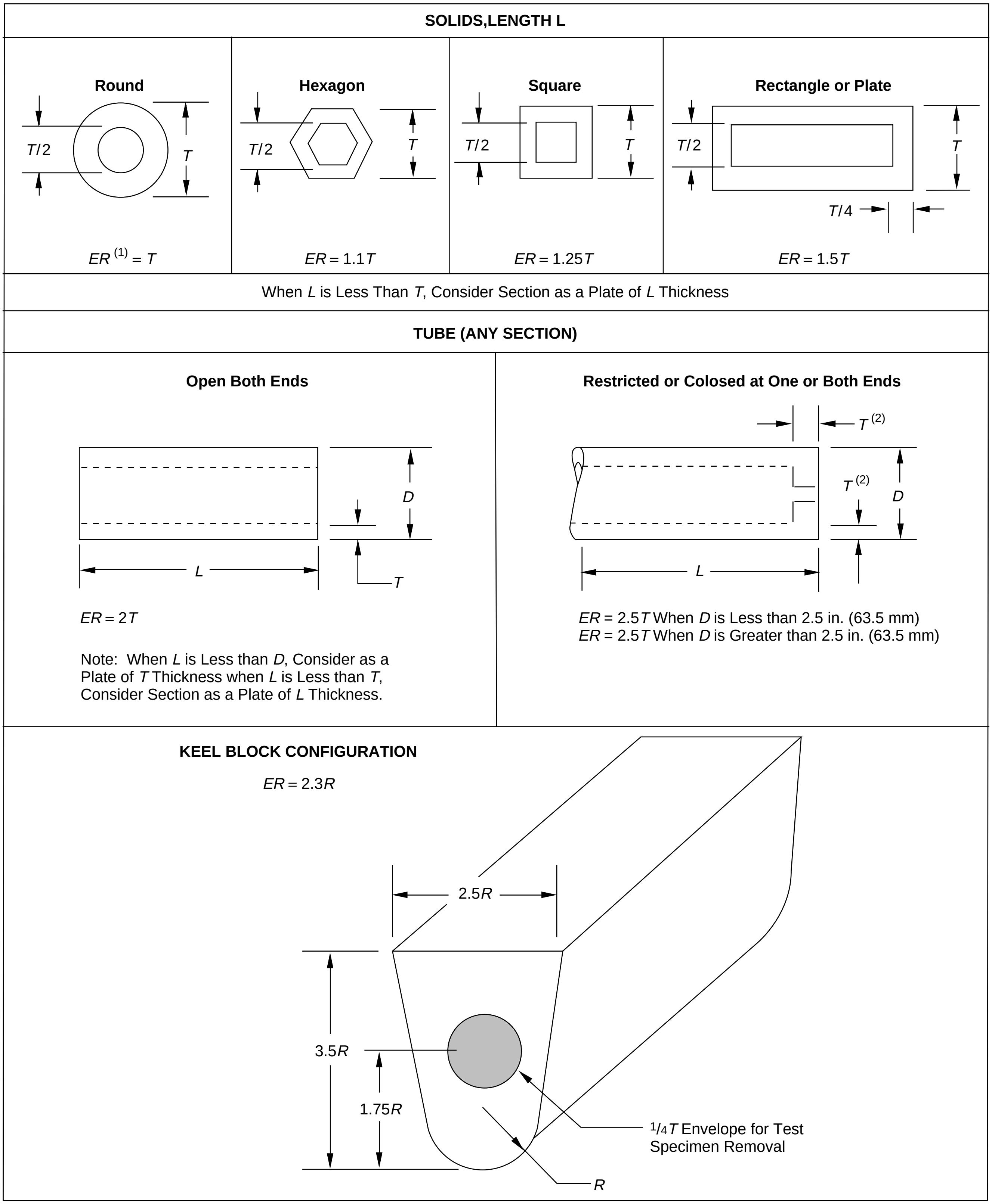
Note: Appendix C of this specification provides recommendations for heat treating equipment qualifications.

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

6.6 CHEMICAL COMPOSITION

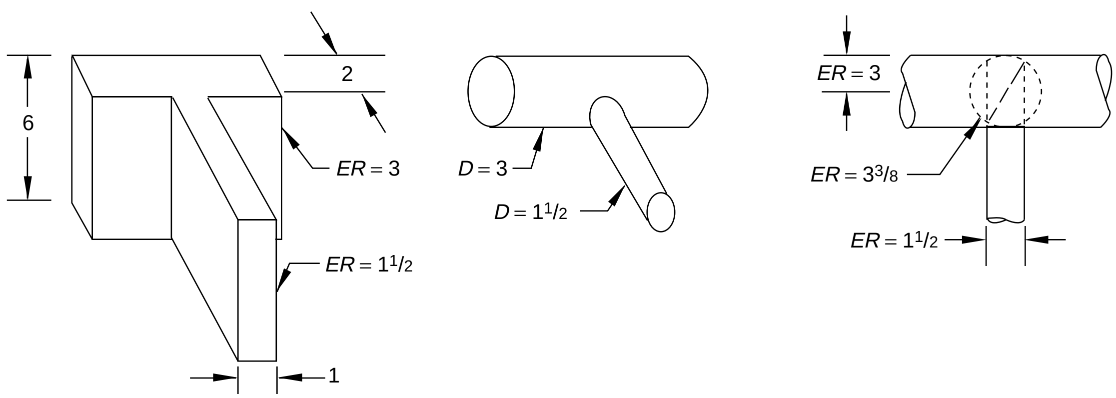
The material composition of each heat shall be analyzed for all elements specified in the manufacturer's written material specification.

For PSL 2, maximum sulfur and phosphorus levels permitted in any component shall be 0.025 weight percent each.



Notes: 1. ER = Equivalent Round
2. Use maximum thickness for calculation

Figure 1—Equivalent Round Models



SIMPLE SECTIONS **_ER_ VALUES** **ER INTERSECTIONAL VALUE**

ER = Equivalent Diameter of Round Bars

The Diagonal Value may be Measured instead of Calculated by Laying out the Intersecting *ER* Values at Right Angles to one another.

The Following Steps should be used in Determining the Governing Equivalent Round for Complex Sections

1. Reduce the components to simple sections.
2. Convert simple sections to *ER* values. The *ER* value at an intersection is equivalent to a diagonal through the diameter of circle which would circumscribe the *ER* area intersection, normal to the larger *ER* section, as shown in the upper right-hand sketch.
3. The maximum *ER* value, whether it is for a single component or an intersection, shall be taken as the *ER* of the complex section.

Figure 2—Equivalent Rounds for Complex Shapes

Given:

$ER = 2\frac{1}{2}$ inches
From Figure 4.1: $ER = 2.3R$

Then:

$R = ER/2.3 = 1.087$ inches
$1.75R = 1.75 \times 1.087 = 1.902$ inches
$2.5R = 2.5 \times 1.087 = 2.718$ inches
$3.5 = 3.5 \times 1.067 = 3.085$ inches

CONSTRUCT KEEL BLOCK

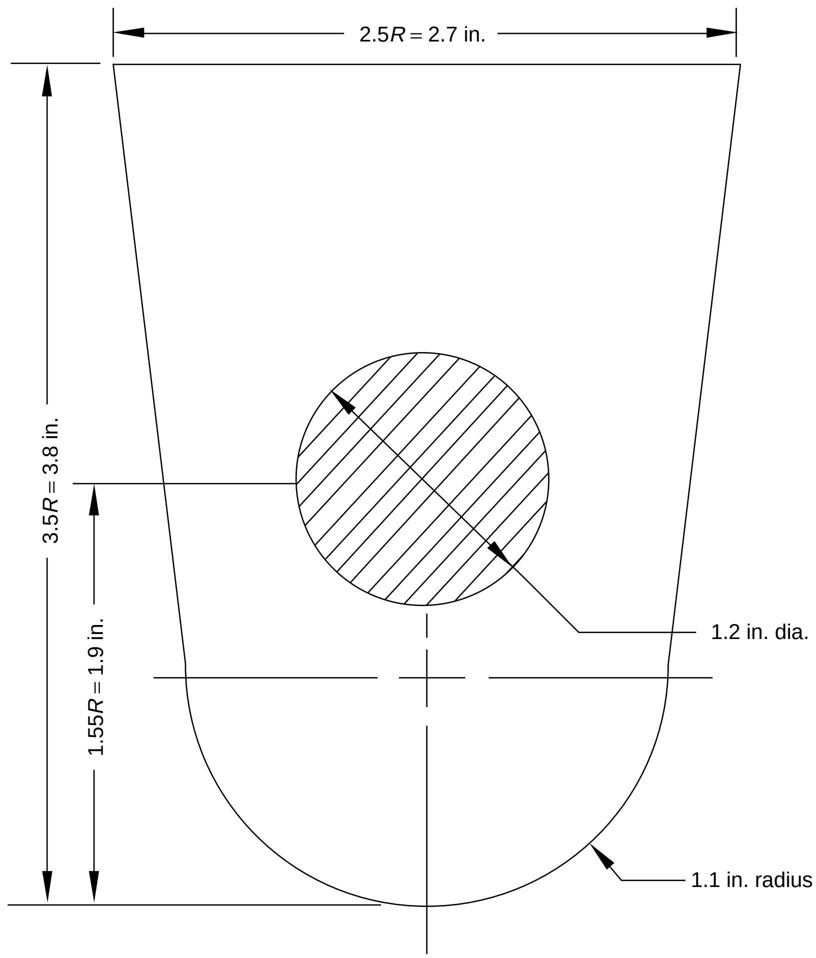


Figure 3—Development of Keel Block Dimensions

7 Welding Requirements

7.1 GENERAL

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

7.2 WELDING QUALIFICATIONS

All welding undertaken on components shall be performed using welding procedures that are qualified in accordance with the following:

a. For PSL 1: ASME B31.3, ASME Code, Section IX, AWS D1.1 and/or ASTM A488.
b. For PSL 2: ASME Code, Section IX.

This welding shall only be carried out by welder or welding operators who are qualified in accordance with the aforementioned standards.

Welding procedures for base materials that are not listed in the above standards shall be qualified individually or as a group based on weldability, tensile properties, or composition. Where the ductility of the parent metal is such as to render it incapable of meeting the bend test requirements of ASME Code, Section IX, the bend test (for PSL 1 or 2) shall be conducted in the following manner: A bend bar composed 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 (WPS) written and qualified in accordance with the applicable standard. The WPS shall describe all the essential, nonessential, and supplementary essential (when required—see ASME Code, Section IX) variables as listed in the applicable standard.

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

7.4 CONTROL OF CONSUMABLES

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

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

7.5 WELD PROPERTIES

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

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

Note: For welded components with weld thickness greater than 1 inch (25.4 millimeters) that are not postweld heat treated, a lowering of the impact test temperature shall be considered by the manufacturer.

7.6 POSTWELD HEAT TREATMENT

Postweld heat treatment of components shall be in accordance with the applicable qualified welding procedure specification (WPS).

7.7 QUALITY CONTROL REQUIREMENTS

Requirements for quality control of permitted welds shall be in accordance with Section 8 of this specification.

7.8 SPECIFIC REQUIREMENTS—FABRICATION WELDS

In addition to the requirements specified in Sections 7.2 to 7.7 the following shall apply: For joint design, weld joint types and sizes shall meet the manufacturer's design requirements and shall be documented in the manufacturer's welding procedure specification.

7.9 SPECIFIC REQUIREMENTS—REPAIR WELDS

In addition to the requirements specified in Sections 7.2 to 7.7, the following shall apply:

7.9.1 Access

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

7.9.2 Fusion

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

7.9.3 Forgings and Castings

All repair welding shall be performed in accordance with the manufacturer's written welding procedure. Welding procedures 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:

a. Defect type.
b. Defect size limits.
c. 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 of this specification.

For PSL 2, major weld repairs as defined in Section 8.4.8.3, the manufacturer shall also produce a dimensional sketch of the area to be repaired and repair sequence.

Documentation of repairs shall be maintained in accordance with requirements of Section 11 of this specification.

7.9.4 Tubulars

Repair welding on wrought tubular goods is not permitted.

7.9.5 Heat treatment

The welding procedure specification used for qualifying a repair shall reflect the actual sequence of weld repair and heat treatment imparted to 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, quantitative, and qualitative acceptance criteria.

Instructions for nondestructive examination (NDE) activities shall be detailed regarding the requirements of this specification and those of all applicable referenced specifications. All NDE instructions shall be approved by an ASNT TC-1A level III examiner or an examiner qualified to a standard recognized by ASNT.

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

8.2.1 NDE Personnel shall be qualified and/or certified in accordance with ASNT TC-1A or an equivalent standard recognized by ASNT.

8.2.2 Personnel performing visual inspection of welding operations and completed welds shall be qualified and certified as follows:

a. AWS-certified welding inspector, or
b. AWS-certified associate welding inspector, or
c. A welding inspector certified by the manufacturer's documented training program.

8.2.3 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, BS 5781), to maintain the required level of accuracy.

8.4 QUALITY CONTROL FOR SPECIFIC EQUIPMENT AND COMPONENTS

The quality control requirements in Section 8.4 shall apply to all primary load bearing and/or pressure containing equipment and components unless specified otherwise.

8.4.1 Chemical Analysis

Methods and acceptance criteria shall be in accordance with Section 6.6.

8.4.2 Tensile Testing

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

8.4.3 Impact Testing

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

8.4.4 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.

8.4.5 Visual Examination

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

8.4.6 Surface NDE

All accessible surfaces of each finished component shall be inspected in accordance wit this section 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 performed a minimum of 24 hours after the load testing. The equipment shall be disassembled for this inspection. Surface coating shall be removed prior to examination.

8.4.6.1 Method

Ferromagnetic materials shall be examined by the magnetic particle (MP) method in accordance with ASME Code, Section 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 may be examined by the wet method.

Nonferromagnetic materials shall be examined by the liquid penetrant (LP) method in accordance with ASME Code, Section V, Subsection A, Article 6, and Subsection B, Article 24 or ASTM E165.

When the use of prods cannot be avoided, all prod burn marks shall be removed by grinding and the affected areas rechecked by LP examination.

8.4.6.2 Definitions of Indications

Only those indications with major dimensions greater than $^{1}/_{16}$ inch (1.6 millimeters) and associated with a surface rupture shall be considered relevant. Inherent indications not associated with a surface rupture (i.e., magnetic permeability variations and nonmetallic stringers) are considered nonrelevant. If magnetic particle indications greater than $^{1}/_{16}$ inch (1.6 millimeters) are believed to be nonrelevant, they shall be examined by liquid penetrant surface NDE or removed and reinspected to prove their nonrelevance.

A linear indication is an indication in which the length is equal to or greater than three times the width.

A rounded indication is an indication that is circular or elliptical with its length less than three times the width.

Note: Relevant indications are to be evaluated in accordance with Acceptance Criteria specified in 8.4.6.3.

8.4.6.3 Acceptance Criteria

8.4.6.3.1 Castings

ASTM E125 (reference photographs for magnetic particle indications on ferrous castings) 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 3 for PSL 1 and Table 4 for PSL 2.

Table 3—PSL 1

		Maximum Permitted Degree	
Type	Discontinuity Descriptions	Critical Areas	Noncritical 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 4—PSL 2

		Maximum Permitted Degree	
Type	Discontinuity Descriptions	Critical Areas	Noncritical 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 defined as all areas where the stress in the component exceeds the value of the following:

$$\text{High Stress} \geq \frac{\text{Specified Minimum Yield Strength}}{(1.33) \times (\text{Design Safety Factor})}$$

If critical areas are not identified on critical area drawings, then all surface area 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 value of the following shall be exempt from the acceptance criteria defined in Tables 3 and 4.

$$\text{Low Stress} \leq \frac{(0.1) \times (\text{Specified Minimum Yield Strength})}{\text{Design Safety Factor}}$$

8.4.6.3.2 Wrought Material

The following acceptance criteria apply for surface examination of wrought materials:

a. No relevant indications with a major dimension equal to or greater than $^3/_{16}$ inch (4.8 millimeters).

b. No more than ten relevant indications in any continuous 6-square-inch (39-square-centimeter) area.

c. No more than three relevant indications in a line separated by less than $^1/_{16}$ inch (1.6 millimeters) edge to edge.

d. No relevant indications in pressure sealing areas, the root area of rotary threads, and stress relief features of thread joints.

8.4.7 Volumetric Nondestructive Examination of Castings

8.4.7.1 Method

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

Ultrasonic examination shall be in accordance with ASME Code, Section V, Sub-section 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 Article 23 and shall be supplemented by angle beam examination as in T-510, T-520, T-541.4.1, T-541.4.2, and T-542.4.3 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.

8.4.7.2 Sampling

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

a. 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.

b. Thereafter, for production lots less than 10, one casting out of every 10 production castings, or for production lots greater than 10, one casting per production lot, shall be volumetrically examined in all critical areas as identified on critical area drawings.

c. Should any casting show any indications outside the acceptance criteria as defined in Section 8.4.7.3, two more castings from that production lot as described above shall be examined by the same method(s) and should either of these two be found nonconforming, all castings of that batch shall be examined. If the two additional castings are acceptable, the remainder of the batch may be accepted and the initial nonconforming casting repaired or scrapped.

8.4.7.3 Acceptance Criteria

8.4.7.3.1 Radiography

The acceptance criteria for radiographic examination are based on the Standard Reference Radiographs of ASTM E445, 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 noncritical areas. Critical areas shall be as defined in Section 8.4.6.3. 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 value of σ_e low stress, defined in Section 8.4.6.3, shall be exempt from volumetric examination.

8.4.7.3.2 Ultrasonic Examination

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

a. For PSL 1: Quality Level 3.

b. For PSL 2: Quality Level 1 for casting thicknesses up to 2 inches (50 millimeters);

Quality Level 2 for casting thicknesses from 2 to 4 inches (50 to 100 millimeters);

Quality Level 3 for casting thicknesses over 4 inches (over 100 millimeters).

In addition, the following conditions shall apply:

a. Regardless of casting thickness, Quality Level 1 shall apply within 2 inches (50 millimeters) of the casting surface.
b. Discontinuities indicated to have a change in depth of 1 inch (25 millimeters) or half the thickness, whichever is the lesser, are not permitted.

8.4.8 Nondestructive Examination of Welds

8.4.8.1 General

When examination is required essential welding variables and equipment shall be monitored, and completed weldments (including a minimum of $^1/_2$ inch (12.7 millimeters) of surrounding base metal) and the entire accessible weld shall be examined in accordance with the methods and acceptance criteria of this section.

The NDE required by this section shall be carried out after final heat treatment.

8.4.8.2 Fabrication Welding

8.4.8.2.1 Visual Examination

All fabrication welds shall be visually examined in accordance with ASME Code, 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 and exposed slag are not permitted on or within $^1/_8$ inch (3 millimeters) of sealing surfaces.

8.4.8.2.2 Surface NDE

All primary load bearing and pressure containing welds and attachment welds to main load bearing and pressure containing components shall be examined as described in Section 8.4.6.1.

The following acceptance criteria shall apply:

a. No relevant linear indication.
b. No rounded indications greater than $^1/_8$ inch (3 millimeters) for welds whose depth is $^5/_8$ inch (16 millimeters) or less or $^3/_{16}$ inch (4.8 millimeters) for welds whose depth is greater than $^5/_8$ inch (16 millimeters).
c. No more than three relevant indications in a line separated by less than $^1/_{16}$ inch (1.6 millimeters) edge to edge.

8.4.8.2.3 Volumetric NDE

Primary load bearing and pressure containing welds shall be examined by either ultrasonic or radiographic methods in accordance with ASME Code, Section V, Subsection A, Article 5 and Article 2 respectively.

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 Code, Section VIII Division I, UW-51 and Appendix 12 as appropriate.

8.4.8.3 Repair Welds

8.4.8.3.1 Weld Preparation Examination

All excavations for weld repairs shall be examined by the magnetic particle method and acceptance criteria as described in Section 8.4.6.2.

8.4.8.3.2 Repair Welds in Castings

All repair welds in castings shall be examined as described in Section 8.4.6.1. Acceptance criteria shall be identical to those for fabrication welds (see Section 8.4.8.2).

For PSL 2, if the depth of repair exceeds 25 percent of the original wall thickness or 1 inch (25.4 millimeters), whichever is lesser, the repair is classified as major and shall also be examined by either radiography or ultrasonic methods. Methods and acceptance criteria shall be as defined for critical areas in Section 8.4.8.2).

8.4.8.3.3 Repair of Welds

NDE requirements for the repair of weld defects are identical to those for the original weld (see Section 8.4.8.2).

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

8.6 PROOF LOAD TESTING

This section describes the proof load testing requirements for the following equipment:

a. Elevators.
b. Links.
c. Spiders (when capable of being used as elevators).
d. Safety clamps when capable of being used as hoisting equipment.

Each production unit of the above equipment shall be load tested in accordance with the requirements of this section.

Equipment not listed shall be load tested if Supplementary Requirement SR 1 is specified in the order.

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 times the rated load shall be applied and held for a period of not less than 5 minutes.

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 bearing parts (excluding bearings).

All critical areas of the primary load bearing parts shall be subjected to magnetic particle examination in conformance with Section 8.4.6.

8.7 HYDROSTATIC TESTING

When hydrostatic testing of equipment is required, as indicated in Section 9, the following general requirements shall apply:

8.7.1 The hydrostatic test shall be carried out in four steps:

a. The primary pressure-holding period.
b. Reduction of the pressure to zero.
c. Thorough drying of external surface of the equipment.
d. The secondary pressure-holding period.

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

8.7.2 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.

Specific hydrotesting requirements are included under the relevant equipment headings of Section 7.

8.8 FUNCTIONAL TESTING

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

9 Equipment

9.1 GENERAL

All of the requirements of Sections 1 through 8 apply to the primary load carrying components of the covered equipment 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 Sheaves NDE

Surface hardened areas of sheave grooves shall be exempt from the requirements of Section 8.4.6. NDE of the groove area may be performed prior to surface hardening the groove.

Sheave webs manufactured from rolled steel plate less than 2 inches (50 mm) thickness and having minimum specified yield strength less than 45,000 psi (310 mPa) shall be exempt from surface NDE.

9.2.3 Sheave Diameter

The sheave diameter shall be the overall diameter, D, shown in Figure 4. Sheave diameters shall, whenever practicable, be determined in accordance with the recommendations given in API Recommended Practice 9B.

9.2.4 Drilling and Casing Line Sheaves

Grooves for drilling and casing line sheaves shall be made for the rope size specified by the purchaser. The bottom of the groove shall have a radius, R, (Table 5) subtending an arc of 150 degrees. The sides of the groove shall be tangent to the ends of the bottom arc. Total groove depth shall be a minimum of $1.33d$ and a maximum of $1.75d$, where d is the nominal rope diameter shown in Figure 4, Detail A.

9.2.5 Sand-Line Sheaves

Grooves for sand-line sheaves shall be made for the rope size specified by the purchaser. The bottom of the groove shall have a radius, R, (Table 5) subtending an arc of 150 degrees. The sides of the groove shall be tangent to the ends of the bottom arc. Total groove depth shall be a minimum of $1.75d$ and a maximum of $3d$, where d is the nominal rope diameter shown in Figure 4, Detail B.

9.2.6 Marking

Sheaves conforming to this specification shall be marked with the manufacturer's name or mark, the sheave groove size and the sheave OD. These marking shall be cast or stamped on the side of the outer rim of the sheave.

Example: A 36-inch (914.4 millimeters) sheave with a $1^1/_8$ inch (28.6 millimeters) groove should be marked as follows:

AB CO 1-1/8 Spec 8C 36

or

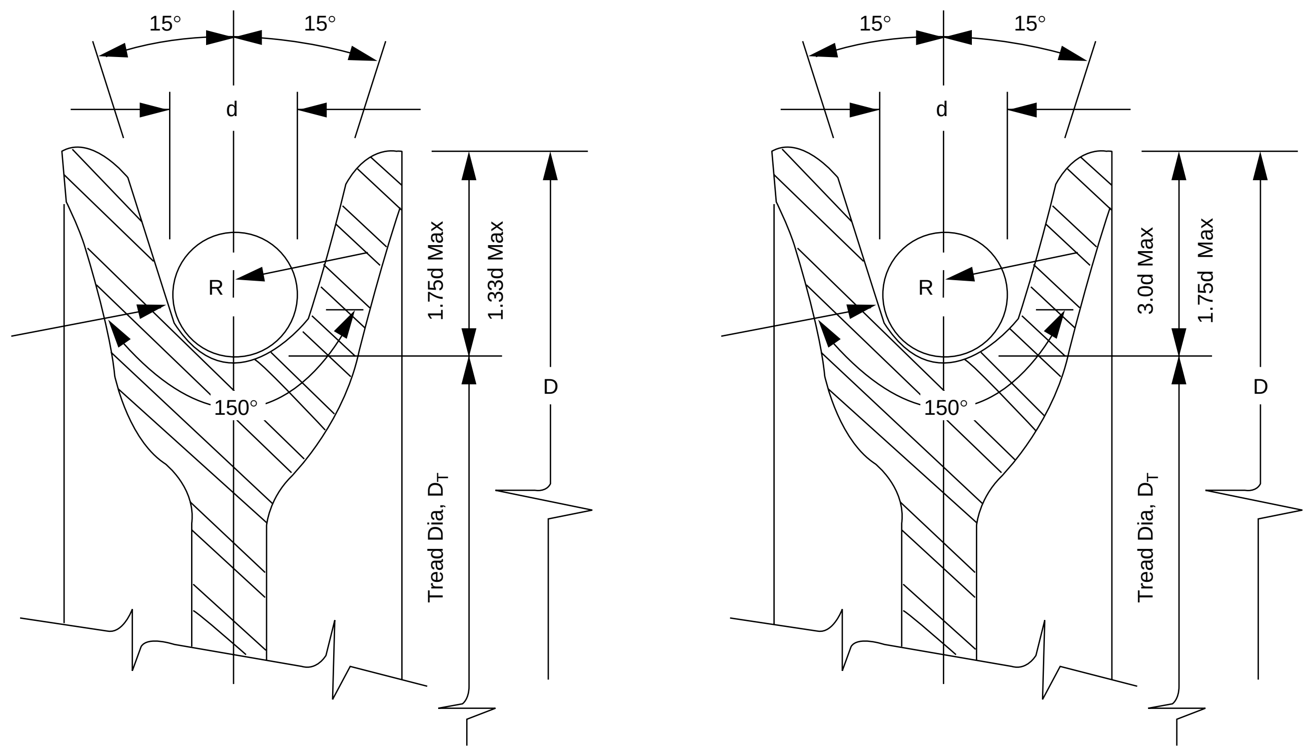
AB CO 1.125 Spec 8C 36

Note: See API Recommended Practice 9B for details of sheave groove gauging practice and worn sheave data.

Table 5—Groove Radii for New and Reconditioned Sheaves and Drums

Nominal Wire Rope Diameter		Groove Radius Minimum		Groove Radius Maximum	
in.	mm	in.	mm	in.	mm
0.250	6.5	0.134	3.40	0.138	3.51
0.313	8	0.167	4.24	0.172	4.37
0.375	9.5	0.199	5.05	0.206	5.23
0.438	11	0.232	5.89	0.241	6.12
0.500	13	0.265	6.73	0.275	6.99
0.563	14.5	0.298	7.57	0.309	7.85
0.625	16	0.331	8.41	0.344	8.74
0.750	19	0.398	10.11	0.413	10.49
0.875	22	0.464	11.79	0.481	12.22
1.000	26	0.530	13.46	0.550	13.97
1.125	29	0.596	15.14	0.619	15.72
1.250	32	0.663	16.84	0.688	17.48
1.375	35	0.729	18.52	0.756	19.20
1.500	38	0.795	20.19	0.825	20.96
1.625	42	0.861	21.87	0.894	22.71
1.750	45	0.928	23.57	0.963	24.46
1.875	48	0.994	25.25	1.031	26.19
2.000	52	1.060	26.92	1.100	27.94
2.125	54	1.126	28.60	1.169	29.69
2.250	58	1.193	30.30	1.238	31.45
2.375	60	1.259	31.98	1.306	33.17
2.500	64	1.325	33.66	1.375	34.93
2.625	67	1.391	35.33	1.444	36.68
2.750	71	1.458	37.03	1.513	38.43
2.875	74	1.524	38.71	1.581	40.16
3.000	77	1.590	40.39	1.650	41.91
3.125	80	1.656	42.06	1.719	43.66
3.250	83	1.723	43.76	1.788	45.42
3.375	86	1.789	45.44	1.856	47.14
3.500	90	1.855	47.12	1.925	48.89
3.750	96	1.988	50.50	2.063	52.40
4.000	103	2.120	53.85	2.200	55.88
4.250	109	2.253	57.23	2.338	59.39
4.500	115	2.385	60.58	2.475	62.87
4.750	122	2.518	63.96	2.613	66.37
5.000	128	2.650	67.31	2.750	69.85
5.250	135	2.783	70.69	2.888	73.36
5.500	141	2.915	74.04	3.025	76.84
5.750	148	3.048	77.42	3.163	80.34
6.000	154	3.180	80.77	3.300	83.82

Note: For wire rope sizes 0.375 inch (9.5 mm) and larger not found on this table use the following equations:
Minimum new grove radius = nominal rope radius + 6%
Maximum groove radius = nominal rope radius + 10%



**Drilling Line &
Casing Line Sheaves**

DETAIL A

Sand-Line Sheave

DETAIL B

Figure 4—Sheave Grooves

9.3 TRAVELING BLOCKS

9.3.1 Sheaves

Traveling block sheaves shall comply with the applicable requirements of Section 9.2.

9.3.2 Sheave Bearing Rating

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

$$W_B = \frac{NW_R}{714}$$

Where:

W_B = Calculated block bearing rating, tons.

N = Number of sheaves in the block.

W_R = Individual sheave bearing rating, pounds at 100 RPM for 3,000-hour minimum life for 90 percent of the bearings.

For antifriction bearing design and manufacturing requirements, see Paragraph 9.15.

9.3.3 Traveling Blocks

Contact surface radii shall comply with the dimensions in Table 9 and Figure 6.

9.3.4 Hook Blocks

Contact surface radii shall comply with the dimensions in Table 9 and Figures 6, 7, and 8. The connection method between the traveling block component and the hook component is left to the manufacturer.

9.3.5 Traveling Block Hood Eye Opening Rating

The traveling block top handling member shall, for 500-ton size class and larger, have a static load rating established based on the same safety factors as required for the primary members as given in Section 4.7.

9.3.6 Traveling Block Hood Eye Opening Marking

Marking in accordance with Section 10.3 shall be placed near the top handling eye connection of traveling blocks rated 500 tons or more. That marking shall indicate the rating of the eye connection, which shall also be considered the gross weight capability as determined from the load rating provisions of this specification.

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

9.5.1 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 9 and Figure 8.

9.5.2 The contact radii of like adapters shall comply with the dimensions in Table 9 and Figures 6, 7, and 8.

9.6 DRILLING HOOKS

Contact surface radii shall comply with the dimensions in Table 9 and Figures 6, 7, and 8.

9.7 ELEVATOR LINKS

9.7.1 Elevator links shall comply with the dimensions in Table 9 and Figure 8.

9.7.2 Elevator links shall be designed and manufactured in pairs. Links up to and including 14 feet (4.3 meters) in length (as measured between the contact surfaces) shall match within $^1/_8$ inch (3 millimeters). Links over 14 feet (4.3 meters) in length shall match within $^1/_4$ inch (6 millimeters).

9.8 ELEVATORS

9.8.1 Drill pipe elevators for use with taper shoulder and square shoulder weld-on tool joints shall have bore dimensions as specified in Table 6.

Casing and tubing elevators shall be suitable to use with casing and tubing manufactured in accordance with API Specification 5CT and shall have bore dimensions as specified in Tables 7 and 8 respectively.

Note: The permissible tolerance on the outside diameter immediately behind the tubing upset may cause problems with slip type elevators.

9.8.2 In addition to the markings specified in Section 10.2, drill pipe elevators shall be marked with the drill pipe size and style from Table 6, column 7.

9.8.3 Design verification testing of slip type elevators/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.

9.8.4 The elevator activating mechanism shall be functionally tested on each production unit demonstrating full compliance with design requirements.

Table 6—Drill Pipe Elevator Bores

1	2	3		4		5		6		7
		Weld-On Tool Joints								
	Drill Pipe Size and Style (All Weights and Grades)	Taper Shoulder				Square Shoulder				
Tool Joint Designation Reference		Neck Diam. D_{TE} Max.[1]		Elev. Bore		Neck Diam. D_{SE} Max.[2]		Elev. Bore		Elev. Marking
		in.	mm	in.	mm	in.	mm	in.	mm	
NC 26($2^3/_8$ IF)	$2^3/_8$ EU	$2^9/_{16}$	65.09	$2^{21}/_{32}$	67.47	*		*		$2^3/_8$ EU
NC 31($2^7/_8$ IF)	$2^7/_8$ EU	$3^3/_{16}$	80.96	$3^9/_{32}$	83.34	$3^3/_{16}$	80.96	$3^3/_8$	87.73	$2^7/_8$ EU
NC 38($3^1/_2$ IF)	$3^1/_2$ EU	$3^7/_8$	98.43	$3^{31}/_{32}$	100.81	$3^7/_8$	98.43	$4^1/_{16}$	103.19	$3^1/_2$ EU
NC 40(4 FH)	$3^1/_2$ EU	$3^7/_8$	98.43	$3^{31}/_{32}$	100.81	$3^7/_8$	98.43	$4^1/_{16}$	103.19	
NC 40(4 FH)	4 IU	$4^3/_{16}$	106.36	$4^9/_{32}$	101.86	$4^1/_8$	104.78	$4^5/_{16}$	109.54	4 IU
NC 46(4 IF)	4 EU	$4^1/_2$	114.30	$4^{25}/_{32}$	121.44	$4^1/_2$	114.30	$4^{13}/_{16}$	122.24	
	$4^1/_2$ IU	$4^{11}/_{16}$	119.06	$4^{25}/_{32}$	121.44	$4^5/_8$	117.48	$4^{13}/_{16}$	122.24	4 EU
	$4^1/_2$ IEU	$4^{11}/_{16}$	119.06	$4^{25}/_{32}$	121.44	$4^5/_8$	117.48	$4^{13}/_{16}$	122.24	$4^1/_2$ IU
$4^1/_2$ FH	$4^1/_2$ IU	$4^{11}/_{16}$	119.06	$4^{25}/_{32}$	121.44	$4^5/_8$	117.48	$4^{13}/_{16}$	122.24	$4^1/_2$ IEU
	$4^1/_2$ IEU	$4^{11}/_{16}$	119.06	$4^{25}/_{32}$	121.44	$4^5/_8$	117.48	$4^{13}/_{16}$	122.24	
NC 50($4^1/_2$ IF)	$4^1/_2$ EU	5	127.00	$5^1/_4$	133.35	5	127.00	$5^5/_{16}$	134.94	$4^1/_2$ EU
	5 IEU	$5^1/_8$	130.18	$5^1/_4$	133.35	$5^1/_8$	130.18	$5^5/_{16}$	134.94	5 IEU
$5^1/_2$ FH	5 IEU	$5^1/_8$	130.18	$5^1/_4$	133.35	$5^1/_8$	130.18	$5^5/_{16}$	134.94	
$5^1/_2$ FH	$5^1/_2$ IEU	$5^{11}/_{16}$	144.46	$5^{13}/_{16}$	147.64	$5^{11}/_{16}$	144.46	$5^7/_8$	149.23	$5^1/_2$ IEU
$6^5/_8$ FH	6 IEU	$6^{15}/_{16}$	175.02	$7^1/_{32}$	178.66					$6^5/_8$ IEU

Note: Elevators with the same bores are the same elevators.
* Not manufactured.
[1]Dimension D_{TE} from API Specification 7.
[2]Dimension D_{SE} from API Specification 7.

Table 7—Casing Elevator Bores

Casing		Elevator Bores			
"D" Casing Dia.		"T_B" Top Bore		"B_B" Bottom Bore	
		±1/64	±.40	+1/32 –1/64	+.79 –.40
in.	mm	in.	mm	in.	mm
$4^1/_2$	114.30	4.594	116.69	4.594	116.69
5	127.00	5.125	130.18	5.125	130.18
$5^1/_2$	139.70	5.625	142.88	5.625	142.88
$6^5/_8$	168.28	6.750	171.45	6.750	171.45
7	177.80	7.125	180.98	7.125	180.98
$7^5/_8$	193.68	7.781	197.64	7.781	197.64
$7^3/_4$	196.85	7.906	200.81	7.908	200.81
$8^5/_8$	219.08	8.781	223.04	8.781	223.04
$9^5/_8$	244.48	9.781	248.44	9.781	248.44
$9^7/_8$	250.83	10.031	254.79	10.031	254.79
$10^3/_4$	273.05	10.938	277.83	10.938	277.83
$11^3/_4$	298.45	11.938	303.23	11.938	303.23
$12^7/_8$	327.03	13.063	331.80	13.063	331.80
$13^3/_8$	339.73	13.563	344.50	13.582	344.50
$13^5/_8$	346.08	13.813	350.85	13.813	350.85
14	355.60	14.203	360.76	14.203	360.76
16	406.40	16.219	411.96	16.219	411.96
$18^5/_8$	473.08	18.875	479.43	18.875	479.43
20	508.00	20.281	515.14	20.281	515.14
$21^1/_2$	546.10	21.781	553.24	21.781	553.24
22	558.80	22.281	565.94	22.281	565.94
24	609.60	24.313	617.55	24.313	617.55
$24^1/_2$	622.30	24.813	630.25	24.813	630.25
26	660.40	26.344	669.14	26.344	669.14
27	685.80	27.344	694.54	27.344	694.54
28	711.20	28.359	720.32	28.359	720.32
30	762.00	30.375	771.53	30.375	771.53
32	812.80	32.391	822.73	32.391	822.73
36	914.40	36.438	925.53	36.438	925.53

Note 1: Bottom bore "B_B" is optional; some elevator designs do not have a bottom bore.
Note 2: Bore sizes take in account a casing tolerance of +1 percent,–0.5 percent on casing outside diameter. If casing diameter including the circumferential weld is within the standard tolerance, these bores can be used.
Note 3: Longitudinal, circumferential, or spiral welds should be considered for grinding flush in the area of possible slip or elevator contact if one or more slips can be set on the weld seam.

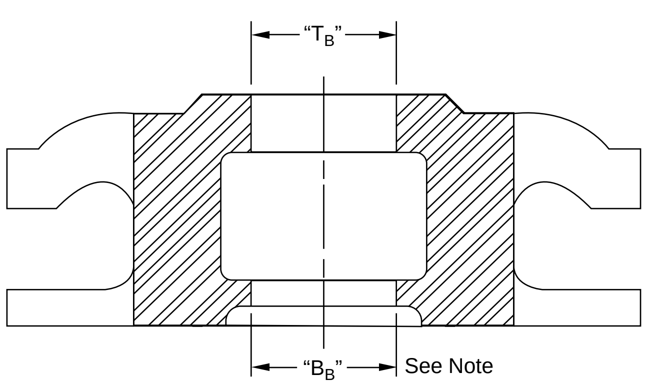
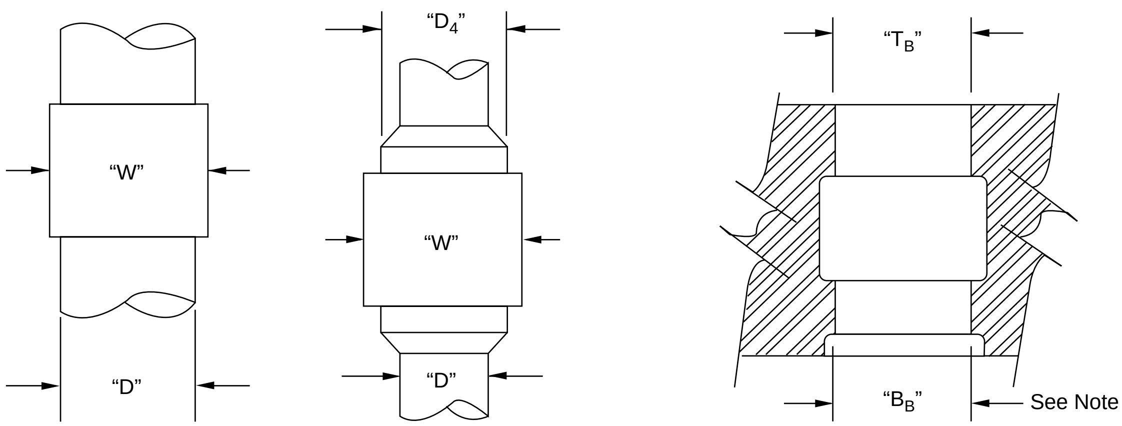


Table 8—Tubing Elevator Bores

Tubing		Non-Upset Tubing						External Upset Tubing									
"D" Size O.D.		"W" Collar Dia.		"T_B" Top Bore		"B_B" Bottom Bore		"W" Collar Dia.		"D_4" Upset Dia.		"T_B" Top Bore		"B_B" Bottom Bore			
				+1.64	±.40mm	+1/32 –1/64	+.79 –.40					+1.64	±.40mm	+1/32 –1/64	+.79 –.40		
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm		
1.050	26.67	1.313	33.35	1.125	28.58	1.125	28.58	1.680	42.16	1.315	33.40	1.422	36.12	1.422	36.12		
1.315	33.40	1.660	42.16	1.390	35.31	1.390	35.31	1.900	48.26	1.469	37.31	1.578	40.08	1.578	40.08		
1.660	42.16	2.054	52.17	1.734	44.04	1.734	44.04	2.200	55.88	1.812	46.02	1.922	48.82	1.922	48.82		
1.900	48.26	2.200	55.88	1.984	50.39	1.984	50.39	2.500	63.50	2.094	53.19	2.203	55.96	2.203	55.96		
$2^3/_8$	60.33	2.875	73.03	2.453	62.31	2.453	62.31	3.063	77.80	2.593	65.89	2.703	68.66	2.703	68.66		
$2^7/_8$	73.03	3.500	88.90	2.953	75.01	2.953	75.01	3.668	93.17	3.094	78.59	3.203	81.36	3.203	81.36		
$3^1/_2$	88.90	4.250	107.95	3.578	90.88	3.578	90.88	4.500	114.30	3.750	95.25	3.859	98.02	3.859	98.02		
4	101.60	4.750	120.65	4.078	103.58	4.078	103.58	5.000	127.00	4.250	107.95	4.359	110.74	4.359	110.74		
$4^1/_2$	114.30	5.200	132.08	4.593	116.66	4.593	116.66	5.563	141.30	4.750	120.65	4.859	123.42	4.859	123.42		

CAUTION: DO NOT USE EXTERNAL UPSET TUBING ELEVATORS ON NON-UPSET TUBING.

Note: Bottom bore "B_B" is optional; some elevator designs do not have a bottom bore.



9.8.5 Inserts are exempt from mechanical testing and traceability requirements.

9.8.6 Slips are exempt from impact testing.

9.9 ROTARY SWIVELS

9.9.1 Swivel Bearing Rating

The bearing rating of swivels shall be determined by the formula:

$$W_S = \frac{W_R}{1600}$$

Where:

W_S = calculated main thrust-bearing rating, tons at 100 RPM.

W_R = main bearing thrust rating, pounds at 100 RPM for 3,000-hour minimum life for 90 percent of bearings.

For antifriction bearing design and manufacturing requirements, see Section 9.15.

9.9.2 Rotary Swivel Prototype Pressure Testing

9.9.2.1 Prototype Test Unit

The assembled test unit shall be statically pressure tested.

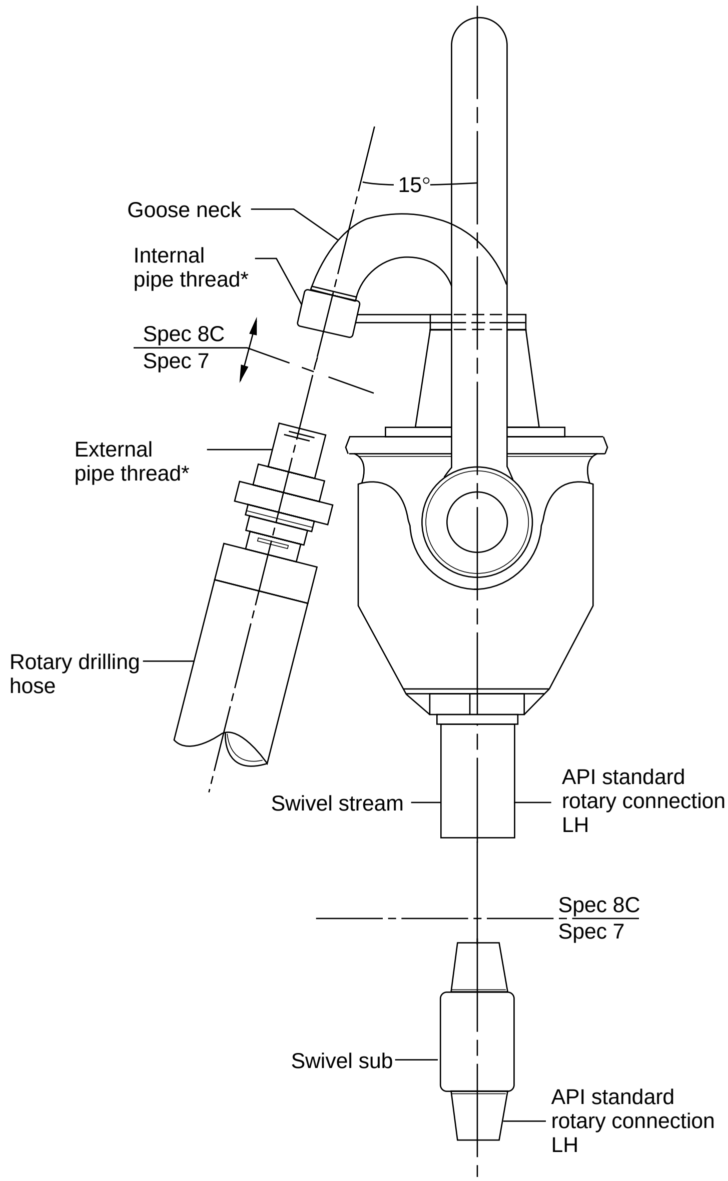
9.9.2.2 Test Pressure

The test pressure shall be twice the working pressure for working pressures up to and including 5,000 psi (344.7 bars). For working pressures above 5,000 psi (344.7 bars), the test pressure shall be one and one-half times the working pressure, but not less than 10,000 psi (689.5 bars). The test pressure shall be held for two cycles of three minutes each per the pressure/time sequence of Section 9.9.3.2.

9.9.3 Production Pressure Testing

9.9.3.1 Cast Components

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.



*Other connections may be used. See Section 9.9.4.1

Figure 5—Rotary Swivel Connections

9.9.3.2 Production Test Pressure and Time Sequence

The hydrostatic pressure test shall consist of four steps:

a. The primary pressure holding period.

b. The reduction of the pressure to zero.

c. All external surfaces of the rotary swivel shall be thoroughly dried.

d. The secondary pressure holding period.

The test pressure shall be equal to the rated working pressure. The pressure holding periods shall not be less than 3 minutes, the timing of which shall not start until the test pressure has been reached, the equipment and pressure monitoring gauge isolated from the pressure source.

During the test pressure holding period, timing will start when pressure stabilization is achieved. During this period, no detectable pressure drop or leakage may occur.

9.9.4 Swivel Gooseneck Connection

9.9.4.1 Dimensions

The angle between the gooseneck centerline and vertical shall be 15 degrees. The connection size and type shall be agreed upon by the purchaser and manufacturer and specified on the purchase order (see Figure 5).

9.9.4.2 Threaded Gooseneck Connections

When a threaded gooseneck connection is specified, the threads shall be nominal size $2^1/_2$, 3, $3^1/_2$, 4, or 5 (inch) internal line pipe threads conforming to API Specification 5B. Nominal size threads shall be marked with the size and type of thread. For example, size 3 threads shall be marked:

3 API LP THD

See Section 10 for further marking requirements.

9.9.5 Rotary Swivel SubConnection

9.9.5.1 The lower connection of rotary swivels shall accept API gauges and be interchangeable with API connections.

9.9.5.2 The connection shall conform to the applicable requirements including gauging and marking as specified in API Specification 7.

9.9.6 Rotary Hose Safety Chain Attachment

Gooseneck connections shall be provided with a suitable lug containing a $1^1/_8$ inch (28 millimeters) diameter hole to accommodate the clevis of a chain having a breaking strength of 16,000 pounds (7,250 kilograms). The location of the lug is the choice of the manufacturer.

9.9.7 Swivel wash pipes

Swivel wash pipes shall be exempt from the impact requirements of Section 6 and the NDE requirements of Section 8.

9.10 POWER SWIVELS

A power swivel is a device that moves with the traveling 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.

9.10.1 Power Swivel Bearing Rating

The bearing rating for power swivels shall be calculated using the formula given in Section 9.9.1.

9.10.2 Power Swivel Testing

Power swivel production testing shall consist of pressure testing in accordance with the requirements of Sections 9.9.2 and 9.9.3.

9.10.3 Power Swivel Gooseneck Connection

Power swivel gooseneck connections shall meet the requirements of Section 9.9.4.

9.10.4 Power Swivel SubConnection

Power swivel sub connections shall meet the requirements of Section 9.9.5.

9.10.5 Rotary Hose Safety Chain Attachment

Rotary hose safety chain attachments shall meet the requirements of Section 9.9.6.

9.11 POWER SUBS

A power sub is a device that moves with the traveling 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.

9.11.1 Power-Sub Gooseneck Extension

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

Table 9A—Recommended Hoisting Tool Contact Surface Radii (Inches)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Rating	Traveling Block & Hook Bail (See Fig. 4A)				Hook & Swivel Bail (See Fig. 4B)				Elevator Link & Hook Link Ear (See Fig. 5)				Elevator Link & Elevator Ear (See Fig. 5)			
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	C_1 Max	C_2 Min	D_1 Min	D_2 Max	G_1 Max	G_2 Min	H_1 Min	H_2 Max
25–40	$2\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{1}{4}$	3	2	$1\frac{1}{2}$	3	3	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$\frac{7}{8}$		1		2
41–65	$2\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{1}{4}$	3	2	$1\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$\frac{7}{8}$		1		2
66–100	$2\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{1}{4}$	3	$2\frac{1}{4}$	2	4	4	$2\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$		1		2
101–150	$2\frac{3}{4}$	$2\frac{3}{4}$	$3\frac{1}{4}$	3	$2\frac{1}{2}$	$2\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$\frac{15}{16}$	$1\frac{1}{2}$	2	2
151–250	4	4	$3\frac{1}{4}$	3	$2\frac{3}{4}$	$2\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	4	4	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{7}{32}$	$1\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$
251–350	4	4	$3\frac{1}{4}$	3	3	$2\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	4	4	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{15}{32}$	$1\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{3}{4}$
351–500	4	4	$3\frac{1}{2}$	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	4	$4\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{7}{8}$	$1\frac{7}{8}$	2	$3\frac{1}{4}$	$3\frac{1}{4}$
501–650	4	4	$3\frac{1}{2}$	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{1}{2}$	4	$4\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{7}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	5	5
651–750	6	6	$3\frac{1}{4}$	$3\frac{1}{4}$	$4\frac{1}{4}$	4	$4\frac{1}{2}$	$4\frac{1}{2}$	4	5	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{3}{8}$	5	5
751–1000	6	6	$6\frac{1}{4}$	6	$5\frac{1}{4}$	5	5	5	$4\frac{1}{2}$	5	3	$2\frac{3}{4}$	$2\frac{3}{4}$	$2\frac{7}{8}$	$6\frac{1}{4}$	$6\frac{1}{4}$

Table 9B—Recommended Hoisting Tool Contact Surface Radii (Millimeters)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Rating	Traveling Block & Hook Bail (See Fig. 4A)				Hook & Swivel Bail (See Fig. 4B)				Elevator Link & Hook Link Ear (See Fig. 5)				Elevator Link & Elevator Ear (See Fig. 5)			
Metric 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	C_1 Max	C_2 Min	D_1 Min	D_2 Max	G_1 Max	G_2 Min	H_1 Min	H_2 Max
22.7–36.3	69.85	69.85	82.55	76.20	50.80	38.10	76.20	76.20	38.10	38.10	31.75	22.23		25.40		50.80
37.2–59	69.85	69.85	82.55	76.20	50.80	44.45	88.90	88.90	63.50	63.50	31.75	22.23		25.40		50.80
59.9–91	69.85	69.85	82.55	76.20	57.15	50.80	101.60	101.60	63.50	63.50	38.10	28.58		25.40		50.80
91.7–136	69.85	69.85	82.55	76.20	63.50	57.15	114.30	114.30	63.50	63.50	38.10	28.58	23.82	38.10	50.80	50.80
137.1–227	101.60	101.60	82.55	76.20	69.85	63.50	114.30	114.30	101.60	101.60	44.45	34.93	30.94	47.63	69.85	69.85
227.9–318	101.60	101.60	82.55	76.20	76.20	69.85	114.30	114.30	101.60	101.60	44.45	34.93	37.31	47.63	69.85	69.85
318.7–454	101.60	101.60	88.90	82.55	88.90	82.55	114.30	114.30	101.60	120.65	57.15	47.63	47.63	50.80	82.55	82.55
454.9–591	101.60	101.60	88.90	82.55	88.90	82.55	114.30	114.30	101.60	120.65	57.15	47.63	57.15	60.32	127.00	127.00
591.1–681	152.40	152.40	88.90	82.55	107.95	101.60	114.30	114.30	101.60	127.00	63.50	63.50	57.15	60.32	127.00	127.00
681.9–908	152.40	152.40	158.75	152.40	133.35	127.00	127.00	127.00	114.30	127.00	76.20	69.85	69.85	73.03	158.75	158.75

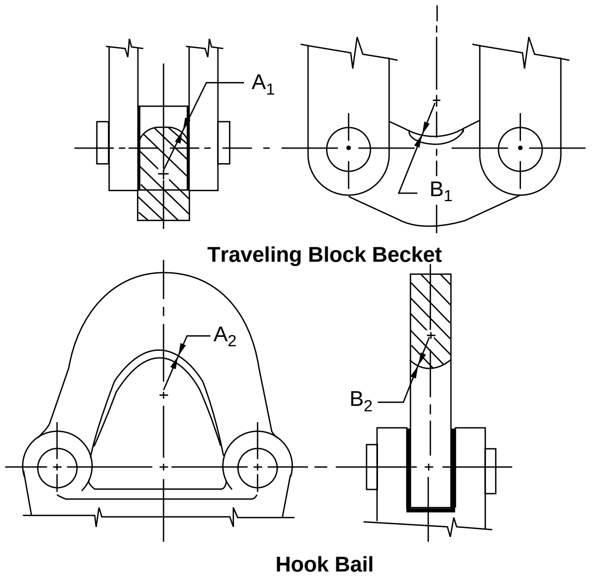


Figure 6—Traveling Block and Hook Bail Contact Surface Radii (See Tables 9A and 9B)

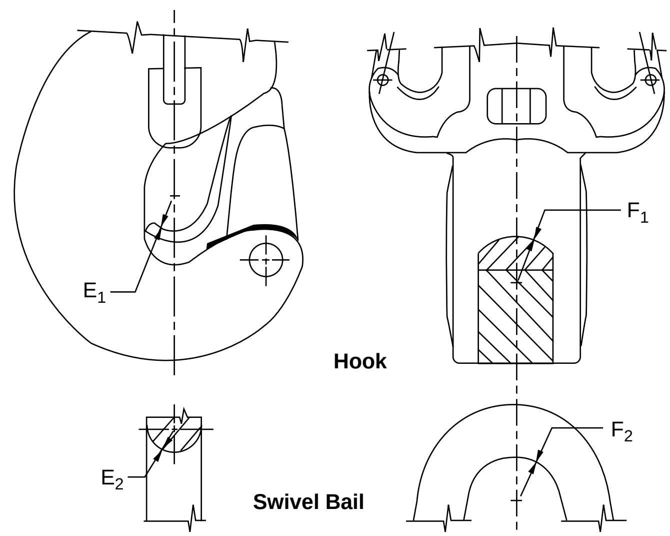


Figure 7—Hook and Swivel Bail Contact Surface Radii (See Tables 9A and 9B)

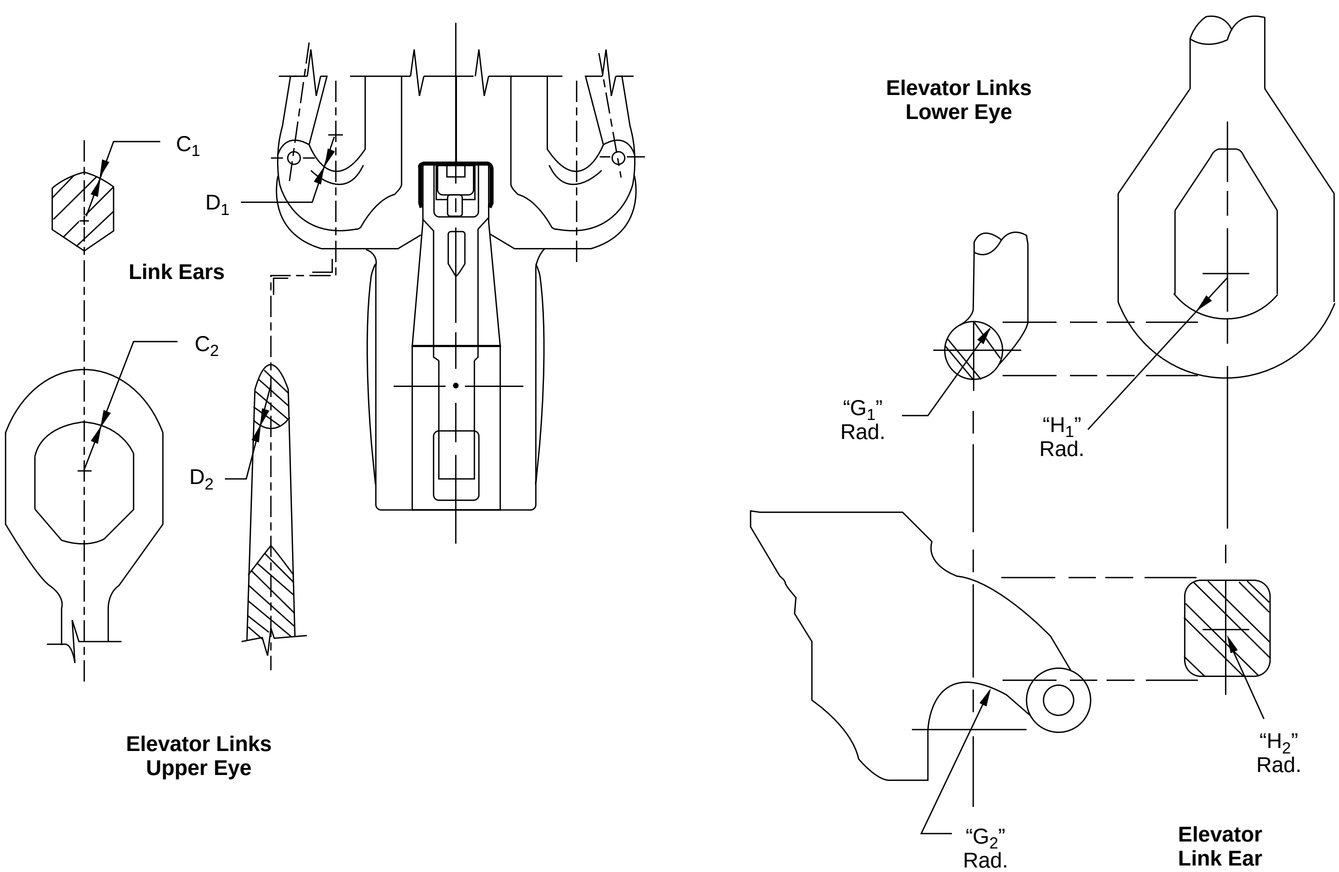


Figure 8—Elevator Link and Link Ear Contact Surface Radii (See Tables 9A and 9B)

9.11.2 Power-Sub Connections

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

9.12 WIRELINE ANCHORS

9.12.1 The size class designation of Section 4.3 do not apply to wireline anchors.

9.12.2 Wireline anchors shall be classed by the rated line pull in kips (1,000 pounds).

9.12.3 The maximum load rating of wireline anchors shall be determined as outlined in Section 4.6 except that the design safety factor shall be determined as follows:

Calculated Rating		
Kips	Kilonewtons	Design Safety Factor, SF_D
40 and less	177.9 and less	3.00
Over 40 to 100, inclusive	177.9 to 444.8, inclusive	$3.00 - 0.75\,(R - 40)/60$
Over 100	444.8	2.25

Note: *Where:* R = Rating in kips (kilonewtons).

9.13 DRILL STRING MOTION COMPENSATORS

9.13.1 Contact surface radii should comply with the dimensions in Table 9 and Figure 6.

9.13.2 Crown block drill string motion compensators shall comply with the requirements of Section 9.

9.14 PRESSURE VESSELS AND PIPING

All pressure vessels and piping forming part of any equipment covered by this specification shall be manufactured in accordance with a recognized code or standard.

9.15 ANTIFRICTION BEARING

Antifriction bearings used as primary load path components shall be designed and manufactured in accordance with a recognized bearing industry code or standard. Antifriction bearings shall be exempt from the requirements of Sections 4, 5, 6, 7, and 8 of this specification.

9.16 SAFETY CLAMPS WHEN CAPABLE OF BEING USED AS HOISTING EQUIPMENT

9.16.1 Inserts are exempt from mechanical testing and traceability requirements.

9.16.2 Manufacturers shall state maximum makeup torque for the clamp to achieve the maximum rated load.

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

10 Marking

10.1 PRODUCT MARKING

Each item of hoisting equipment furnished in conformance with this specification shall be marked with the manufacturer's name or mark, the relevant PSL number and the rating specified in Section 10.2. Additional markings shall be applied in accordance with the requirements set out in Section 9 and Section 10.4. Equipment for which supplementary requirements apply shall be marked with the relevant "SR" numbers.

10.2 RATING MARKING

All items of hoisting equipment designed and manufactured to this specification shall be marked with design load/pressure rating. The rating in metric ton shall also be marked on the equipment subject to space availability.

Example: A traveling block rated 650 short tons (590 metric ton) should be marked as follows:

AB CO 650 Specification 8A

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 design load rating.

10.4 COMPONENT TRACEABILITY

Primary load carrying and/or pressure containing components shall be uniquely marked as specified in Section 8.4.4, 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 Sections 10.1, 10.2, 10.3, and 10.5 shall be low-stress hard die stamped or cast into components and shall be clearly visible and at least $^3/_8$ inch (10 millimeters) high where the physical dimensions of the component will permit. Marking referred to in Section 10.5 shall be clearly legible.

11 Documentation

11.1 GENERAL

Full records of any documentation referenced in this specification shall be kept by the manufacturer for a period of 10 years after the equipment has been monogrammed. Documentation shall be clear, legible, reproducible, retrievable, and protected from damage, deterioration, or loss.

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

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

11.2 DOCUMENTATION TO BE KEPT BY THE MANUFACTURER

The following documentation shall be kept by the manufacturer:

a. Design documentation (see Section 4.10).
b. Design verification documentation (see Section 5.8).
c. Written specifications (see Sections 6, 7, and 8).
d. Qualification records such as the following:
   1. Weld procedure qualification records.
   2. Welder qualification records.
   3. NDE personnel qualification records.
   4. Measuring and test equipment calibration records.
e. Inspection and test records traceable to the equipment or components, including the following:
   1. Material test reports covering the following tests, as applicable:
      — chemical analysis
      — tensile tests
      — impact tests
      — hardness tests
   2. NDE records covering the surface and/or volumetric NDE requirements of Section 8 of this specification.
   3. Performance test records including:
      — proof load testing records
      — hydrostatic pressure testing records
      — functional testing records
   4. Special process records, including actual heat treatment time/temperature charts and weld repair records as described in Section 7. These records shall be traceable to the applicable components and shall be maintained by the manufacturer or by the party carrying out the special process if the work is subcontracted. In the latter case the requirements of 11.1 shall apply equally to the subcontractor.

11.3 DOCUMENTATION TO BE DELIVERED WITH THE EQUIPMENT

11.3.1 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 specification 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 the following:
   1. Assembly drawings.
   2. List of components.
   3. Nominal capacities and ratings.
   4. Operating procedures.
   5. Recommended frequency of field inspection and preventive maintenance, methods, and acceptance criteria.
   6. Itemized spare parts (not applicable to single component equipment) and recommended stock levels.
   7. PSL 2: capacity changes as result of wear.

11.3.2 A comprehensive data book can be specified by the purchaser by calling out Supplementary Requirement SR 3 in the purchase order.

APPENDIX A—SUPPLEMENTARY REQUIREMENTS

By agreement between the purchaser and the manufacturer, and when specified in the purchase order, one or more of the following supplementary requirements shall apply:

SR 1 Proof Load Testing

The equipment shall be load tested and subsequently examined in accordance with the requirements of Section 8.6 of this specification.

The equipment shall be marked "SR 1" by means of low-stress hard die stamping near the load rating identification.

SR 2 Low-Temperature Testing

For design temperatures below –4°F (–20°C), this supplementary requirement shall apply.

Components shall be fabricated from materials possessing acceptable notch toughness at the specified minimum design temperature. The minimum average Charpy impact energy on three full-size test pieces shall be 20 foot-pounds (27 joules) with no individual value less than 15 foot-pounds (20 joules).

Impact testing shall be performed in accordance with the requirements of Section 6.3 of this specification and ASTM A370.

Each component shall be marked "SR 2" to indicate that low-temperature testing has been performed. Each component shall also be marked with the temperature in °C below zero to indicate the actual design and test temperature.

SR 3 Data Book

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

a. Statement of compliance.
b. Equipment designation/serial number.
c. Assembly and critical area drawings.
d. Nominal capacities and ratings.
e. List of components.
f. Traceability codes and systems (marking on parts/records on file).
g. Steel grades.
h. Heat treatment records.
i. Material test reports.
j. NDE records.
k. Performance test records including functional hydrostatic and load testing certificates (when applicable).
l. Supplementary requirements certificates as required.
m. Welding procedure specifications and qualification records.

SR 4 Additional Volumetric Examination of Castings

The requirements for SR 4 shall be identical to the requirements for Section 8.4.7, except that all critical areas of each primary load bearing casting shall be examined.

SR 5 Volumetric Examination of Wrought Material

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

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 that exceeds the calibration reference line shall be classed as a defect. Any indication interpreted as a crack or thermal rupture shall also be considered a defect.
b. There shall be no multiple indications exceeding 50 percent of the reference distance amplitude curve. Multiple indications are defined as two or more indications (each exceeding 50 percent of the reference distance amplitude curve) within $^1/_2$ inch (12.7 millimeters) of each other in any direction.

Ultrasonic examination shall be in accordance with ASTM A388 (immersion method may be used) and ASTM E428. Straight beam calibration shall be used per a distance amplitude curve based on $^1/_8$ inch (3mm) or less flat bottom hole.

APPENDIX B—METRIC CONVERSIONS

Imperial units are in all cases preferential and shall be the standard in this specification. These factors were taken from API Standard 2564.

Length:	1 inch (in.) = 25.4 millimeters (mm) exactly
Pressure:	1 pound per square inch (psi) = 0.0684757 bar [Note: 1 bar = 100 kilopascals (kPa).]
Strength of Stress:	1 pound per square inch (psi) = 0.006894757 megapascals (mPA)
Impact Energy:	1 foot-pound (ft-lb) = 1.355818 joules (J)
Torque:	1 foot-pound (ft-lb) = 1.355818 newton-meters (Nm)
Temperature:	The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C): °C = 5/9(°F – 32)
Mass:	1 pound (lb) = 0.4535924 kilograms (kg)
Weight:	1 short ton (ton) = 0.908 metric ton (Mton) 1 kip = 4.448 kilonewtons (kN) [Note: 1 kip = 1,000 pounds.]

APPENDIX C—HEAT TREATING EQUIPMENT

C.1 Temperature Tolerance

The temperature at any point in the working zone shall not vary by more than ±25°F (±14°C) from the furnace set point temperature after the furnace working zone has been brought up to temperature. Furnaces that are used for tempering, aging, and/or stress relieving shall not vary by more than ±25°F (±14°C) from the furnace set point temperature after the furnace working zone has been brought up to temperature.

C.2 Furnace Calibration

C.2.1 GENERAL

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

C.2.2 RECORDS

Records of furnace calibration and surveys shall be maintained for a period not less than 2 years.

C.2.3 BATCH-TYPE FURNACE METHODS

C.2.3.1 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.

C.2.3.2 A minimum of nine thermocouple test locations shall be used for all furnaces having a working zone greater than 10 cubic feet (0.283 cubic meters).

C.2.3.3 For each 125 cubic feet (3.539 cubic meters) of furnace working zone surveyed, at least one thermocouple test location shall be used up to a minimum of 60 thermocouples. See Figure C-1 for thermocouple locations.

C.2.3.4 For furnaces having a working zone less than 10 cubic feet (0.283 cubic meters), the temperature survey may be made with a minimum of three thermocouples located at the front, center, and rear or at the top, center and bottom of the furnace working zone.

C.2.3.5 After insertion of the temperature-sensing devices, readings shall be taken at least once every 3 minutes to determine when the temperature of the furnace working zone approaches the bottom of the temperature range being surveyed.

C.2.3.6 Once the furnace temperature has reached the set point temperature, the temperature of all test locations shall be recorded at 2-minute intervals maximum for at least 10 minutes. Then readings shall be taken at 5-minutes intervals maximum for sufficient time to determine the recurrent temperature pattern of the furnace working zone for at least 30 minutes.

C.2.3.7 Before the furnace set point temperature is reached, none of the temperature readings shall exceed the set point temperature by 25°F (14°C).

C.2.3.8 After the furnace control set point temperature is reached, no temperature readings shall exceed the limits specified. Each furnace shall be surveyed within 1 year prior to heat treating.

C.2.3.9 When a furnace is repaired or rebuilt, a new survey shall be required before heat training.

C.2.4 CONTINUOUS TYPE FURNACE METHOD

Continuous heat treating furnaces shall be calibrated in accordance with procedures specified in Section 3 of MIL-H-6875F, *Heat Treatment of Steels—Aircraft Practice Process.*

C.3 Instruments

C.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 protecting devices.

C.3.2 ACCURACY

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

C.3.3 CALIBRATION

C.3.3.1 Temperature controlling and recording instruments shall be calibrated at least once every 3 months.

C.3.3.2 Equipment used to calibrate the production equipment shall possess an accuracy of ±0.25 percent of full scale.

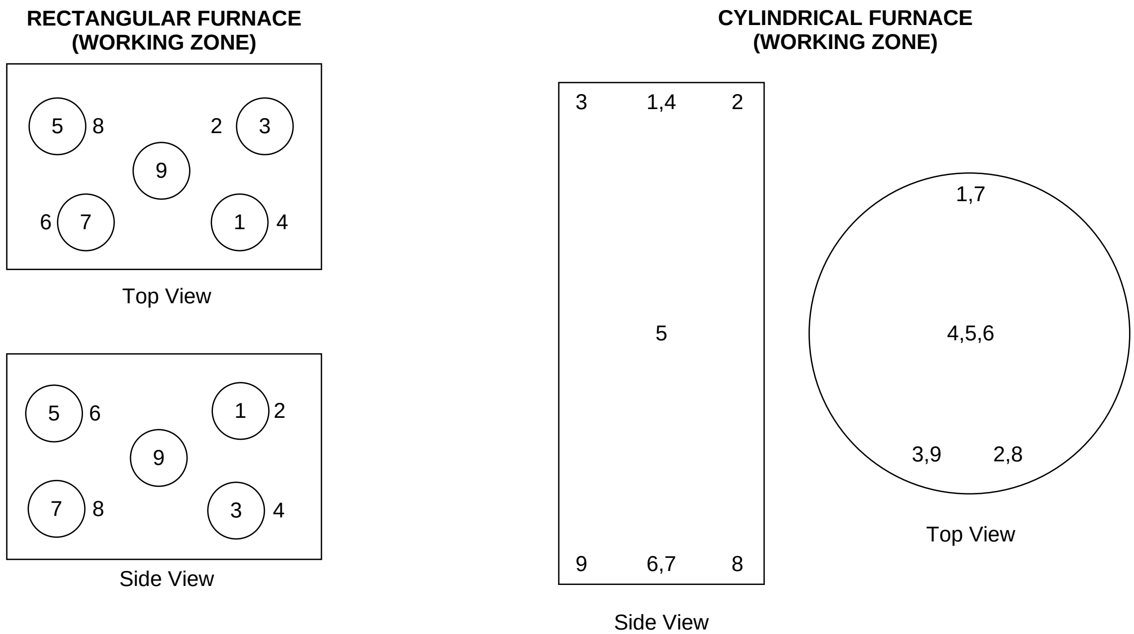


Figure C-1— Thermocouple Locations

APPENDIX D—GUIDE DOLLIES

D.1 General

D.1.1 The purpose of the guide dolly is to hold the traveling equipment in correct position in relation to the derrick under the various operations. A retractable dolly shall also be able to move the traveling equipment horizontally between the drilling position and the retracted position.

D.1.2 According to the definition in Section 3 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 in D.1.1, the dolly will be subjected to considerable forces. Besides the horizontal forces transmitted through the dolly between the traveling equipment and the derrick, vertical forces are also transmitted between the dolly and the traveling equipment. This is due to the weight of the dolly, amplified by possible vertical acceleration of the dolly.

D.1.3 The transmission of forces between the dolly and the derrick takes place via vertical guide rails mounted on the derrick.

D.2 Principal Loading Conditions and Corresponding Safety Factors

D.2.1 Members and cross sections, including hydraulic cylinders and connected equipment, shall be designed for the most unfavorable of the following three principal loading conditions (PLC) using the associated safety factors shown in the tabulation:

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

D.2.2 The loads and load combination to be considered in each of the PLCs defined in D.2.1 shall be as defined in D.3.1, D.3.2, and D.3.3.

D.3 Loads and Load Combinations

D.3.1 PLC I

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

D.3.1.1 LC I, 1—Drilling

This includes the effect of weight of the power swivel and dolly and the drilling torque (applies to power swivel dollies only).

D.3.1.2 LC I, 2—Braking

This includes the effect of the traveling equipment, including the dolly, multiplied by and appropriate factor, usually not less than 2.

D.3.1.3 LC I, 3—Retraction/Extension

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

D.3.1.4 LC I, 4—Horizontal Pull

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

D.3.2 PLC II

In PLC II the four load combinations defined in 5.1 shall be considered together with appropriate "operating environmental conditions." In the case of a fixed platform this will normally include wind only, acting in the most unfavorable direction. In the case of a floating platform (or drill ship) the effect of heel, trimand platform movements shall also be considered.

D.3.3 PLC III

In PLC III the following load combinations shall be considered:

D.3.3.1 LC III, 1—Exceptional Vertical Accelerations (Jarring or Drill String Failure)

The situation will normally be represented by the effect of weight of the traveling equipment, including the dolly, multiplied by an appropriate factor, usually not less than 4.

D.3.3.2 LC III, 2—Exceptional Environmental Conditions

This load combination shall, in addition to weight, include environmental loads having 100 years' return period. In the case of a fixed platform, the environmental load will normally be wind only.

D.3.3.3 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 degrees shall be considered.

D.3.3.4 LC III, 4—Setback Conditions

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

D.4 Fatigue Considerations

D.4.1 Retractable dollies shall at least be checked for fatigue effect of the stress cycles caused by the retraction/extension movements. The calculated fatigue life should be at least three times the estimated service life.

D.4.2 Vibration during drilling is a possible cause of fatigue effect for power swivel dollies. Therefore, the design should aim in general at avoiding vibrations as well as stress risers.

D.5 Special Safety Precautions

D.5.1 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 maximum allowable acceleration of the traveling equipment.

D.5.2 The manufacturer shall prepare a maintenance and operation manual in accordance with Section 11.

APPENDIX E—USE OF THE API MONOGRAM (SEE NOTE)

Note: API licensees only. Contact API for information on licensing.

E.1 Marking

The following marking requirements apply to licensed manufacturers using the API monogram on products covered by this specification.

E.2 Sheave Marking

Sheaves conforming to this specification shall be marked with the manufacturer's name or mark, the sheave groove size, the API license number, monogram, and date of manufacture and sheave OD. These markings shall be cast or stamped on the side of the outer rim of the sheave.

Example: A 36 inch (914.4 millimeter) sheave with $1^1/_8$ inch (28.6 millimeter groove should be marked as follows:

AB CO l $^1/_8$ 8C XXXX.X **MO-YR 36**

E.3 Product Marking

Each item of hoisting equipment furnished in conformance with this specification shall be marked with the manufacturer's name or mark, and the rating or class designation marking specified. In addition, authorized manufacturers may mark all such items with the API monogram when preceded by the API license number and followed by the date of manufacture. Additional markings may be applied at the option of the manufacturer.

Example: A traveling block rated 650 short tons (590 metric tons) should be marked as follows:

AB CO 650 8C XXXX.X **MO-YR**

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