

# Specification for Choke and Kill Systems

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## SECTION 1

### SCOPE

**1.1 PURPOSE.** This specification was formulated to provide for safe and functionally interchangeable surface and subsea choke and kill systems equipment utilized for drilling oil and gas wells. Other parts of the Choke and Kill System not specifically addressed in this document shall be in accordance with the applicable sections of this specification.

Technical content provides the minimum requirements for performance, design, materials, welding, testing, inspection, storing and shipping.

#### 1.2 APPLICATIONS

**1.2.1 EQUIPMENT.** Equipment, specific to and covered by this specification, is listed below:

- Actuated valve control lines
- Articulated Choke & Kill Line
- Drilling choke actuators
- Drilling choke control lines, exclusive of BOP control lines and subsurface safety valve control lines
- Drilling choke controls
- Drilling chokes
- Flexible choke and kill lines
- Union connections
- Rigid choke and kill lines
- Swivel unions

**1.2.2 OTHER EQUIPMENT.** Other Equipment included in specification, but covered by other API Specifications is listed below:

- Check valves
- Chokes
- Crosses and tees
- Flanged, studded end and outlet connections
- Flow through valves
- Hubbed end and outlet connections
- Production choke actuators
- Ring gaskets
- Studs and nuts
- Threaded end connections
- Valve actuators

**1.3 SERVICE CONDITIONS.** Service conditions refer to requirements for pressure, temperature and fluid compatibility as delineated in Section 3, Design Requirements.

Because Choke and Kill Systems are mobile and are moved to different areas, all service conditions they may be exposed to cannot be defined in this document. However, conditions that are consistent with API Specifications 6A and 16A have been adopted, which define a sour, moderately corrosive environment. If severe corrosion, abrasion, temperatures or high levels of sour gas are expected, the user and manufacturer shall jointly address the requirements and determine the suitable product for the application.

#### 1.4 PRODUCT SPECIFICATION

1. This specification establishes minimum requirements for products listed in Section 1.2.1, Equipment.

2. Products listed in Section 1.2.2, Other Equipment, that have requirements established in API Specification 6A, 16th edition shall have a minimum of product specification level PSL 3, material class EE and a Temperature Rating from Section 3.5.2 as appropriate for Choke and Kill System applications.

3. Choke and Kill System equipment manufactured prior to the effective date of this specification is outside the scope of this document.

**1.5 REFERENCED STANDARDS.** This specification includes by reference, either in total or in part, other API, Industry and Governmental Standards listed in Table 1.5.3 Referenced Standards.

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

**1.5.2 ALTERNATE STANDARDS.** Other nationally or internationally recognized standards shall be submitted to and approved by API for inclusion in this specification prior to use as equivalent requirements.

**TABLE 1.5.3**  
**REFERENCED STANDARDS**

The Standards referenced below relate to the latest edition.

ITEM	STANDARD
1.	ANSI/ASME Code for Pressure Piping, Section B31.3, Chemical Plants and Petroleum Refinery Piping.
2.	API Spec 5B: Specification for Threading, Gaging and Thread Inspection of Casing, Tubing and Line Pipe Threads.
3.	API Spec 6A: Specification for Wellhead and Christmas Tree Equipment.
4.	API Spec 16A: Specification for Drill Through Equipment.
5.	API Spec 16C: Choke and Kill Systems.
6.	API RP-53: Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells.
7.	ASME Boiler & Pressure Vessel Code, Section VIII, Division 1, Part UG-101: Proof Testing to Establish Maximum Allowable Working Pressure.
8.	ASME Boiler & Pressure Vessel Code, Section VIII, Division 2, Alternate Rules. (1) Appendix 4: Design Based on Stress Analysis (2) Appendix 6: Experimental Stress Analysis
9.	ASME Boiler & Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
10.	ASTM A 370: Test Methods and Definitions for Mechanical Testing of Steel Products.
11.	ASTM A 388: Practice for Ultrasonic Examination of Heavy Steel Forgings.
12.	ASTM A 609: Practice for Castings, Carbon, Low-alloy, and Martensitic Stainless Steel, Ultrasonic Examination.
13.	ASTM D 975: Specification for Diesel Fuel Oils
14.	ASTM D 1415: Test Method for Rubber Property — International Hardness.
15.	ASTM D 1418: Practice for Rubber and Rubber Latexes — Nomenclature.
16.	ASTM D 2240: Test Method for Rubber Property — Durometer Hardness.
17.	ASTM E 10: Standard Test Method for Brinell Hardness of Metallic Materials.
18.	ASTM E 18: Standard Test Methods for Rockwell Hardness of Metallic Materials.
19.	ASTM E 92: Standard Test Method for Vickers Hardness of Metallic Materials.
20.	ASTM E 94: Guide for Radiographic Testing.
21.	ASTM E 140: Standard Hardness Conversion Tables for Metals.
22.	ASTM E 165: Standard Practice for Liquid Penetrant Inspection.
23.	ASTM E 186: Reference Radiographies for Heavy Walled Steel Castings.
24.	ASTM E 280: Reference Radiographies for Heavy Walled Steel Castings.
25.	ASTM E 428: Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection.
26.	ASTM E 446: Reference Radiographies for Steel Castings up to 2 inches in Thickness.
27.	ASTM E 709: Magnetic Particle Examination.
28.	ASTM E 747: Method of Controlling Quality of Radiographic Testing Using Wire Parameters.
29.	ASTM D 975: Standard Specification for Diesel Fuel Oils.
30.	MIL-H-6875F: Heat Treatment of Steels — Aircraft Practices Processes.
31.	MIL-STD-105D: Sampling Procedures and Tables for Inspection by Attributes.
32.	NACE Standard MR0175-91: Sulfide Stress Cracking Resistant-Metallic Materials for Oilfield Equipment.
33.	SAE J 517: Hydraulic Hose.
34.	SNT-TC-1A: Personnel Qualification and Certification in Non-Destructive Testing.

**1.6 DIMENSIONAL UNITS.** For the purpose of this specification the decimal inch system is the standard for dimensions. Nominal sizes will continue to be shown in fractions. The Appendix, Section 3 gives fraction to decimal equivalence. For the purposes of this specification, the fractions and the decimal equivalents are equal and interchangeable.

**1.7 METRIC/SI CONVERSION.** Metric system or International System of Units conversions are listed in Section 10.1. SI unit dimensions are listed in parentheses alongside the decimal inch units throughout the document.

**1.8 APPENDICES.** Section 10 shall not be considered as requirements. The Appendices are included as guidelines or information.

## SECTION 2

### ABBREVIATIONS & DEFINITIONS

#### 2.1 ABBREVIATIONS

<b>ANSI</b>	American National Standards Institute
<b>API</b>	American Petroleum Institute
<b>ASME</b>	American Society of Mechanical Engineers
<b>ASTM</b>	American Society for Testing and Materials
<b>AWS</b>	American Welding Society
<b>°C</b>	Temperature degrees in Centigrade
<b>°F</b>	Temperature degrees in Fahrenheit
<b>ft</b>	feet
<b>ft<sup>2</sup></b>	square feet
<b>ft<sup>3</sup></b>	cubic feet
<b>ft-lbs</b>	foot pounds
<b>HAZ</b>	Heat affected zone (welding)
<b>&gt;</b>	greater than
<b>ID</b>	internal diameter
<b>in.</b>	inches
<b>ksi</b>	1000 pounds per square inch stress
<b>l</b>	liters
<b>lbs</b>	pounds
<b>&lt;</b>	less than
<b>max.</b>	maximum
<b>MIL</b>	-[n] = Military Specification
<b>MIL</b>	STD = Military Standard
<b>min.</b>	minimum
<b>mm</b>	millimeter
<b>MPa</b>	Megapascals
<b>NA</b>	not applicable
<b>NACE</b>	National Association of Corrosion Engineers
<b>NDE</b>	non-destructive examination
<b>OD</b>	outside diameter
<b>PQR</b>	Welding Procedure Qualification Record
<b>psi</b>	pounds per square inch
<b>PSL</b>	Product Specification Level (API Specification 6A)
<b>QTC</b>	qualification test coupon
<b>SAE</b>	Society of Automotive Engineers
<b>temp</b>	temperature
<b>WPS</b>	Welding Procedure Specifications

#### 2.2 DEFINITIONS

**Acceptance Criteria** — Defined limits placed on characteristics of materials, products, or services.

**Accessible Wetted Service** — Those wetted surfaces which could be viewed for NDE purposes by direct line of

sight. This excludes test ports, control line ports, lock down screw holes and other penetrations of these types.

**Actuator** — A mechanism for the remote or automatic operation of a valve or choke.



**API Monogram** — A registered mark of the American Petroleum Institute.

**Articulated Line** — An articulated line is a choke and kill line assembled as a unit, with rigid pipe, swivel joints and end connections, designed to accommodate specified relative movement between end terminations.

**As shipped condition** — The condition of the product or equipment when it is ready for shipment.

**Body** — Any portion of API equipment between end connections, with or without internal parts, which contains well bore pressure.

**Bolting** — Threaded fasteners (studs, nuts, bolts and cap screws) used to assemble pressure containing parts or join end or outlet connections.

**Bonnet** — A pressure containing closure for a body, other than an API end or outlet connection.

**Calibration** — Comparison and adjustment to a standard of known accuracy.

**Casting** — (1) An object at or near finished shape obtained by solidification of a substance in a mold.

(2) Pouring molten metal into a mold to produce an object of desired shape.

**Chemical Analysis** — Determination of the chemical composition of material.

**Choke** — Equipment used to restrict and control the flow of fluids.

**Choke Bean (Flow Bean)** — The replaceable orifice part used in positive chokes to control flow rates.

**Conformance** - Compliance with specified requirements.

**Carbon Steel** — An alloy of carbon and iron containing a maximum of 2% carbon, 1.65% manganese, and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminum).

**Corrosion Resistant Alloys** — Nonferrous based alloys where any one or the sum of the specified amount of the following alloy elements exceeds 50%: titanium, nickel, cobalt, chromium, and molybdenum.

**Corrosion Resistant Ring Grooves** — Ring grooves lined with metal resistant to metal loss corrosion.

**Critical Components** — Those parts which have specified requirements in this document.

**Date of Manufacture** — The date of manufacturer's final acceptance of finished equipment.

**Degasser** — A system which separates the gas phase from multiphase fluids.

**Dynamic Seal** — Seals in which motion exists relative to the sealing surface after installation.

**End** — Fitting end assembly containing a flexible terminator and end connection used on choke and kill lines.

**End and Outlet Connections** — API integral threads and API flanges, API hubs or API unions used to join together equipment that contains or controls pressure.

**End Termination** — Part of the end fitting which forms the transition between the flexible line construction and the end connector.

**Equipment** — Any single completed unit that can be used for its intended purpose without further processing or assembly (e.g., a valve, choke, cross, tee, spool, etc.).

**Fit** — (1) The geometric relationship between parts. This would include the tolerance criteria used during the design of a part and its mating parts.

(2) The state of being adjusted to or shaped for, this would include the tolerance criteria used during the design of a seal and its mating parts.

**Flange** — A protruding rim with holes to accept bolts and having a sealing mechanism used to join pressure containing equipment, and with dimensions specified by API.

**Flange, Blind** — A flange with no center bore, used to close off completely a flanged end or outlet connection.

**Flange, Loose** — A flange, as manufactured, not intended to be made integral with another piece of API equipment. There are blind, threaded, spacer, welding neck, studded, or other connected adapter flanges.

**Flange, Threaded** — A flange having a sealing face on one side and female thread on the other for the purpose of joining flanged connections to threaded connections.

**Flange, Welding Neck** — A flange with a neck on the side opposite the sealing face prepared with a bevel to weld to corresponding pipe or transition pieces.

**Forging** — (1) Plastically deforming metal, usually hot, into desired shapes with compressive force, with or without dies.

(2) A shaped metal part formed by the forging method.

**Form** — The essential shape of a product including its component parts.

**Function** — The operation of a product during service.

**Gage and Test Port Connections** — Holes drilled and tapped into API Spec equipment through which internal pressure may be measured or through which pressure may be applied to test the sealing mechanisms.

**Heat Affected Zone (HAZ)** — That portion of the base metal which has not been melted, but whose mechanical properties or microstructure has been altered by the heat of welding or cutting.

**Heat (Cast Lot)** — Material originating from a final melt. For remelted alloys, a heat shall be defined as the raw material originating from a single remelted ingot.

**Heat Treatment (Heat Treating)** — Alternate steps of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties.

**Hold Period** — The period of time that the product is subjected to pressure and isolated from the pressure source.

**Hot Working** — Deforming metal plastically at a temperature above the re-crystallization temperature.

**Low Alloy Steel** — Steel containing less than 5% total alloying elements, but more than specified for carbon steel. Although not generally considered a low alloy steel, steels with less than 11% chromium shall be included in this category.

**Material Performance Basis** — Capabilities which must be demonstrated, as a minimum, for material to satisfy the criteria of this standard.

**Post Weld Heat Treatment** — Any heat treatment subsequent to welding, including stress relief.

**Pressure Containing Parts** — Those parts whose failure to function as intended would result in a release of retained fluid to the atmosphere. Examples are bodies, bonnets, and stems.

**Pressure Integrity** — The structural and leak resistant capability of a product to contain applied pressure.

**Pressure Vessel Quality** — Metallic material whose integrity is such that it can be used to safely contain pressure without risk of leakage or rupture.

**Qualified Personnel** — Individuals with characteristics or abilities gained through training, experience, or both, as measured against the manufacturer/user/API established requirements.

**Rated Working Pressure** — The maximum internal pressure equipment is designed to contain and/or control. Working pressure is not to be confused with test pressure.

**Records** — Retrievable information.

**Remotely Operated** — Controlled at a remote location by hydraulic, pneumatic or electrical actuation.

**Retained Fluid** — The actual fluid produced by a well.

**Room Temperature** — Any temperature between 40 and 120 degrees Fahrenheit.

**Serialization** — Assignment of a unique code to individual parts and/or pieces of equipment to maintain records.

**Shall** — In this document the word "shall" is used to indicate requirements which must be satisfied or performed in order to comply with this specification.

**Specified Material** — The material meeting a particular performance requirement(s) as specified by a manufacturer or industry standard.

**Stainless Steel** — Steel containing chromium, more than 11%, to render the steel corrosion resistant. Other elements may be added to secure special properties.

**Static Seal** — Seals in which no motion exists relative to sealing surfaces after installation.

**Stress Corrosion Cracking** — The cracking which results from a combination of corrosion and stress.

**Stress Relief** — Controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses after welding.

**Sulfide Stress Cracking** — Cracking of metallic materials due to exposure to hydrogen sulfide containing fluids.

**Traceability, Job Lot** — The ability for parts to be identified as originating from a job lot which identified the included heat(s).

**Valve, Check** — A valve that permits fluid to flow freely in one direction and contains a mechanism to automatically prevent flow in the other direction.

**Valve, Gate** — A valve assembly with a gate operating within the body, 90 degrees to the conduit, to effect a closure.

**Visual Examination** — Examination of parts and equipment for visible defects in material and workmanship.

**Volumetric Nondestructive Examination** — Examination for internal material defects by methods such as radiography and/or ultrasonic testing.

**Weld, Fabrication** — A weld joining two or more parts.

**Weld, Non-Pressure Containing** — A weld, the absence of which will not reduce the pressure containing integrity of the part.

**Weld, Pressure Containing** — A weld, the absence of which will reduce the pressure containing integrity of the part.

**Weld Groove** — An area between two metals to be joined that has been prepared to receive weld filler metal.

**Weld Joint** — A description of the way components are fitted together in order to facilitate joining by welding.

**Welding** — The fusion of materials, with or without the addition of filler materials.

**Wetted Surface** — Any surface which will be in contact with pressurized well fluid either by design or because of internal seal leakage.

**Yield Strength** — The stress level measured at room temperature, expressed in pounds per square inch of loaded area, at which material plastically deforms and will not return to its original dimensions when the load is released. Yield strengths specified in this standard shall be considered as being the 0.2% yield offset strength per ASTM A 370.

## SECTION 3 DESIGN REQUIREMENTS

**3.1 DESIGN METHOD.** Design method shall be in accordance with one or more of the following criteria.

**3.1.1 ASME METHOD.** The design methodology as described in the ASME Boiler Code & Pressure Vessel Code, Section VIII, Division 2, Appendix 4, shall be used for design calculations. Design allowable stresses shall be limited by the following criteria:

$$S_m = 2/3 S_y \text{ and } S_t = 0.9 S_y$$

where:

$S_m$  = design stress intensity at rated working pressure

$S_y$  = material minimum specified yield strength

$S_t$  = maximum allowable primary membrane stress intensity at hydrostatic test pressure.

**3.1.2 DISTORTION ENERGY THEORY METHOD.**

The Distortion Energy Method shall be used for design calculations for unions. The minimum pressure design thickness shall be calculated by combining triaxial stresses based on the distortion energy method, using either one of the limits below. Secondary stresses and stress concentrations are beyond the scope of this method.

1. The rated working pressure:

$$S_o = 2/3 S_y$$

$S_o$  = von Mises equivalent stress

2. The hydrostatic test pressure limited by the following criterion:

$$S_o = S_y$$

**3.1.3 EXPERIMENTAL STRESS ANALYSIS.** Experimental Stress Analysis as described in ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, Appendix 6, shall be used.

**3.1.4 PROOF TEST ANALYSIS.** Proof testing as described in ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Part UG-101, shall be used.

**3.2 PERFORMANCE REQUIREMENTS.** Performance requirements are specific and unique to the product in the as shipped condition. Products shall be designed to perform according to the requirements of this section and in the pressure, temperature ranges, test fluids, and in accordance with Section 4.

**3.2.1 PRESSURE INTEGRITY.** Products shall be capable of withstanding rated working pressure at rated temperature without deformation to the extent that any other performance requirement is not met.

**3.2.2 THERMAL INTEGRITY.** Products and/or systems shall be capable of functioning throughout the temperature range for which they are rated.

**3.2.3 LEAKAGE.** No visible leakage is allowed.

**3.2.4 LOAD CAPABILITY.** Products shall be capable of sustaining rated loads without deformation to the extent that any other performance requirement is not met.

**3.2.5 CYCLES.** Products shall be capable of performing and operating as intended for the number of operating cycles specified in Section 9 for applicable products.

**3.2.6 OPERATING FORCE OR TORQUE.** The force or torque required to operate products shall be within

the manufacturer's written specification, which includes acceptance criteria.

**3.3 PERFORMANCE VERIFICATION.** The performance verification procedures are imposed on designs of new products and on designs resulting from changes. Verification testing specified in this section is intended to be performed on line samples representative of production models.

**3.3.1 PERFORMANCE VERIFICATION REQUIREMENTS.** Performance verification requirements are set forth in Section 9.

**3.3.2 PRODUCT CHANGES.** A design that undergoes a substantive change becomes a new design requiring performance verification. A substantive change is a change identified by the manufacturer which affects the performance of the product in the intended service condition. This includes changes in fit, form, function or material.

**3.4 BORE SIZES & RATED WORKING PRESSURES.** The bore size and rated working pressure designation of a choke and kill system and the components shall consist of the values delineated in Table 3.4.1, Equipment Bore Sizes and Rated Working Pressures, Table 3.4.2 and Table 3.4.3.

**TABLE 3.4.1  
EQUIPMENT BORE SIZES AND RATED  
WORKING PRESSURES**

Size (minimum through bore) in. (mm)	Rated Working Pressure psi (MPa)
2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)	2000 (13,8)
2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)	3000 (20,7)
2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)	5000 (34,5)
1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	10,000 (69,0)
1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	15,000 (103,5)
1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	20,000 (138)

**NOTE:** Specific size and pressure rating combinations are not necessarily available for each type of end or outlet connection (e.g. flange, hub and threaded).

**TABLE 3.4.2**  
**UNION, SWIVEL JOINT AND ARTICULATED**  
**LINE SIZES & RATED WORKING PRESSURES**

Nominal Size in. (mm)	Rated Working Pressure psi (MPa)
2 (50,8) 3 (76,2) 4 (101,6)	3000 (20,7)
1 (25,4) 1 ½ (38,1) 2 (50,8) 3 (76,2) 4 (101,6)	5000 (34,5)
1 (25,4) 2 (50,8) 3 (76,2) 4 (101,6)	10,000 (69,0)
2 (50,8) 2 ½ (63,5) 3 (76,2)	15,000 (103,5)
2 (50,8) 2 ½ (63,5) 3 (76,2)	20,000 (138,0)

**TABLE 3.4.3**  
**FLEXIBLE LINE SIZES & RATED**  
**WORKING PRESSURES**

ID in. (mm)	Rated Working Pressure psi (MPa)
2 (50,8) 3 (76,2) 3 ½ (88,9) 4 (101,6)	5000 (34,5)
2 (50,8) 2 ½ (63,5) 3 (76,2) 4 (101,6)	10,000 (69,0)
2 (50,8) 2 ½ (63,5) 3 (76,2)	15,000 (103,5)
2 (50,8) 2 ½ (63,5) 3 (76,2)	20,000 (138,0)

### 3.5 SERVICE CONDITIONS

**3.5.1 RATED WORKING PRESSURE.** Equipment within the scope of this specification shall be rated in only the following working pressures, psi (MPa): 2000 (13,8), 3000 (20,7), 5000 (34,5), 10,000 (69,0), 15,000 (103,5), and 20,000 (138,0) psi (MPa), as delineated in Section 3.4.

**3.5.2 TEMPERATURE RATINGS.** Minimum temperature is the lowest ambient temperature to which the equipment may be subjected, while in service. Maximum temperature is the highest fluid temperature which may flow through the equipment, while in service. Equipment shall be designed to operate within the temperature ranges shown in Table 3.5.2.1.

**TABLE 3.5.2.1**  
**TEMPERATURE RATING FOR METALLIC &**  
**NONMETALLIC MATERIALS & FLEXIBLE LINES**

Rating	Operating Range °F (°C)
A	-4 to 180 (-20 to 82)
B	-4 to 212 (-20 to 100)
K	-75 to 180 (-60 to 82)
P	-20 to 180 (-29 to 82)
U	0 to 250 (-18 to 121)

**3.5.3 FLUID SERVICE CONDITIONS.** Choke and Kill Systems are generally mobile and may be expected to be used in areas where sour service conditions may be encountered. Metallic materials which come in contact with the well fluid shall meet the requirements of NACE Standard MR0175-91.

**3.5.4 FLANGE & HUB END AND OUTLET CONNECTIONS.** Flanges and hubs are designed in accordance with design criteria and methods developed by the API Committee on Standardization of Valves and Well-head Equipment and the API Committee for Drill Through Equipment. End and outlet connections are described in this specification. Design is not within the scope of this specification. Manufacturers shall make the end and outlet connections as per the applicable sections of API Specifications 6A & 16A.

**3.6 CLOSURE BOLTING.** The maximum allowable tensile stress for closure bolting shall be determined considering initial bolt up rated working pressure, and hydrostatic test pressure conditions. Bolting stresses, based on the root area of the thread, shall not exceed the following limits:

$$S_a = 0.83S_y$$

where:

$S_a$  = maximum allowable tensile stress

$S_y$  = bolting material specified minimum yield strength

Bolting stresses shall be determined considering all loading on the closure including pressure acting over the seal area, gasket loads and any additive mechanical and thermal loads.

**3.7 CLAMPS.** Clamps for API 16BX Hubs are not included in this specification edition or the current API Specification 16A. Clamps will be addressed in a future edition of these specifications.



**TABLE 3.8**  
**FRACTION TO DECIMAL CONVERSION**

Fraction To Decimal Conversions						
	8 <sup>th</sup>	16 <sup>th</sup>	32 <sup>nd</sup>	64 <sup>th</sup>	0.000	0.00
				1/64	0.016	0.02
			1/32		0.031	0.03
				3/64	0.047	0.05
		1/16			0.062	0.06
				5/64	0.078	0.08
			3/32		0.094	0.09
				7/64	0.109	0.11
	1/8				0.125	0.12
				9/64	0.141	0.14
			5/32		0.156	0.16
				11/64	0.172	0.17
		3/16			0.188	0.19
				13/64	0.203	0.20
			7/32		0.219	0.22
				15/64	0.234	0.23
1/4					0.250	0.25
				17/64	0.266	0.27
			9/32		0.281	0.28
				19/64	0.297	0.30
		5/16			0.312	0.31
				21/64	0.328	0.33
			11/32		0.344	0.34
				23/64	0.359	0.36
	3/8				0.375	0.38
				25/64	0.391	0.39
			13/32		0.406	0.41
				27/64	0.422	0.42
		7/16			0.438	0.44
				29/64	0.453	0.45
			15/32		0.469	0.47
				31/64	0.484	0.48
1/2					0.500	0.50

Fraction To Decimal Conversions						
	8 <sup>th</sup>	16 <sup>th</sup>	32 <sup>nd</sup>	64 <sup>th</sup>	0.000	0.00
				33/64	0.516	0.52
			17/32		0.531	0.53
				35/64	0.547	0.55
		9/16			0.562	0.56
				37/64	0.578	0.58
			19/32		0.594	0.59
				39/64	0.609	0.61
	5/8				0.625	0.62
				41/64	0.641	0.64
			21/32		0.656	0.66
				43/64	0.672	0.67
		11/16			0.688	0.69
				45/64	0.703	0.70
			23/32		0.719	0.72
				47/64	0.734	0.73
3/4					0.750	0.75
				49/64	0.766	0.77
			25/32		0.781	0.78
				51/64	0.797	0.80
		13/16			0.812	0.81
				53/64	0.828	0.83
			27/32		0.844	0.84
				55/64	0.859	0.86
	7/8				0.875	0.88
				57/64	0.891	0.89
			29/32		0.906	0.91
				59/64	0.922	0.92
		15/16			0.938	0.94
				61/64	0.953	0.95
			31/32		0.969	0.97
				63/64	0.984	0.98
1					1.000	1.00

**3.9 TEST, VENT, PIPE PLUGS AND GAUGE CONNECTIONS.** Test, vent, pipe plugs and gauge connections for use on 2000 (13,8), 3000 (20,7), 5000 (34,5), 10,000 (69,0), 15,000 (103,5), and 20,000 (138,0) psi (MPa) equipment shall be as per API Specification 6A, Section 911. Vent connections shall be in accordance with manufacturers written specification.

**3.10 DESIGN DOCUMENTATION.** Documentation of designs shall include methods, assumptions, calculations, and design requirements. Design documentation media shall be clear, legible, reproducible and retrievable.

**3.10.1 DESIGN REVIEW.** Design documentation shall be reviewed and verified by qualified personnel other than those who created the original design.

**3.10.2 DESIGN VERIFICATION.** Manufacturer's shall document their verification procedures and the results of performance verification of designs. Design verification is not required on API flanges, hubs and ring gaskets.

**3.10.3 DOCUMENTATION RETENTION.** Design documentation shall be retained for ten years after the last unit of that model, size, and rated working pressure is manufactured.

## SECTION 4 MATERIAL REQUIREMENTS

This section describes the material performance, processing and compositional requirements for pressure containing parts. Other parts shall be made of materials which satisfy the design requirements in Section 3 when assembled into API Specification 16C equipment. Metallic materials in direct contact with well fluids shall also meet the requirements for sour service of NACE Standard MR0175-91.

**4.1 WRITTEN SPECIFICATIONS.** Metallic and non-metallic pressure containing parts shall have a manufacturer's written material specification.

**4.1.1 METALLIC PARTS.** The manufacturer's written specifications shall include:

1. Acceptance and/or rejection criteria
2. Allowable melting practice(s)
3. Forming practice(s)
4. Heat treatment procedure including cycle time and temperature with tolerances, heat treating equipment and cooling media.
5. Material composition requirements, with tolerances
6. Material qualification
7. Mechanical property requirements
8. NDE requirements

**4.1.2 NON-METALLIC PARTS.** The manufacturer's written specifications shall include:

1. Generic base polymer (ASTM D 1418)
2. Physical properties requirements

3. Material qualifications and physical property changes after testing

4. Storage and age control requirements

5. NDE requirements

6. Acceptance and/or rejection criteria

**4.1.3 SPECIAL MATERIALS.** Special corrosion and abrasion resistant materials, coatings, or facings shall comply with manufacturer's written specifications, which shall include acceptance and/or rejection criteria.

### 4.2 DRILLING CHOKES

**4.2.1 BODIES, BONNETS, PLUGS, CAPS AND END CONNECTIONS.** Materials for these parts shall comply with and Table 4.5.2 and Table 4.5.3.

**4.3 CLOSURE BOLTING.** Closure bolting material shall comply with manufacturer's written specification, which includes acceptance criteria.

**4.4 FLEXIBLE LINES.** Flexible lines shall meet the requirements of Section 9.14.11.

**4.5 PRESSURE CONTAINING PARTS, BODIES, BONNETS, STEMS AND END CONNECTIONS.** Pressure containing parts including bodies, bonnets and API end connections shall be fabricated from materials as specified by the manufacturer that meet the requirements of Table 4.5.2, Table 4.5.5.2, Table 4.5.3 and Table 4.5.5.4.

**4.5.1 IMPACT REQUIREMENTS.** Charpy V-Notch impacts shall meet the values of Table 4.5.6.7.

**TABLE 4.5.2  
PRESSURE CONTAINING PARTS MATERIAL PROPERTY REQUIREMENTS<sup>1</sup>**

API Material Designation	Yield Strength <sup>2</sup> minimum psi (MPa)	Tensile Strength minimum psi (MPa)	Elongation Minimum %	Reduction in Area minimum %
36K	36,000 (248)	70,000 (483)	21	None specified
45K	45,000 (310)	70,000 (483)	19	32
60K	60,000 (414)	85,000 (586)	18	35
75K	75,000 (517)	95,000 (655)	18	35

<sup>1</sup> Reference ASTM A 370

<sup>2</sup> Reference ASTM A 370, Offset method

**TABLE 4.5.3  
PRESSURE CONTAINING PARTS MATERIAL DESIGNATION**

API MATERIAL DESIGNATION						
Part	Rated Working Pressure psi (MPa)					
	2000 (13.8)	3000 (20.7)	5000 (34.5)	10,000 (69.0)	15,000 (103.5)	20,000 (138.0)
body, bonnet & rigid piping	36K,45K,60K,75K	36K,45K,60K,75K	36K,45K,60K,75K	36K,45K,60K,75K	45K,60K,75K	60K,75K
end & outlet connection						
blind flange	60K	60K	60K	60K	75K	75K

**4.5.4 PROCESSING**

**4.5.4.1 MELTING PRACTICES.** The manufacturer shall have a written specification for the melting practices for pressure containing parts and materials.

**4.5.4.2 CASTING PRACTICES.** The manufacturer shall have a written specification which establishes limits for sand control, core making, rigging and melting.

**4.5.4.3 HOT WORKING PRACTICES.** The materials manufacturer shall have a written specification for hot working practices. Wrought materials shall be formed using a hot working practice which produces a wrought structure throughout the part.

**4.5.5 METALLIC PARTS CHEMICAL COMPOSITION.** The manufacturer's written specification shall specify the chemical range of material used to manufacture pressure containing parts. Material composition shall be determined on a heat basis (or a remelt ingot basis for remelt grade materials).

**4.5.5.1 COMPOSITION LIMITS.** Table 4.5.5.2 lists element limits for carbon and low alloy steels and for martensitic stainless steels used to manufacture pressure containing parts. Non-martensitic alloy systems are not required to conform to Table 4.5.5.2.

**TABLE 4.5.5.2  
PRESSURE CONTAINING PARTS MATERIAL  
STEEL COMPOSITION MAXIMUM LIMITS (WT%)**

Alloying Element	Carbon and Low Alloy Steels	Martensitic Stainless Steels
Carbon	0.45	0.15
Chromium	2.75	11.0-14.0
Manganese	1.80	1.00
Molybdenum	1.50	1.00
Nickel	1.00	4.50
Phosphorous	0.025	0.025
Silicon	1.00	1.50
Sulfur	0.025	0.025
Vanadium	0.30	NA

**4.5.5.3 ALLOY ELEMENT RANGE.** Table 4.5.5.4 lists the range requirements for elements used to form materials.

**TABLE 4.5.5.4  
ALLOYING ELEMENT MAXIMUM TOLERANCE  
RANGE REQUIREMENTS (WT%)**

Alloying Elements	Carbon & Low Alloy Steels	Martensitic Stainless Steels
Carbon	0.08	0.08
Chromium	0.50	-
Manganese	0.40	0.40
Molybdenum	0.20	0.20
Nickel	0.50	1.00
Silicon	0.30	0.35
Vanadium	0.10	0.10

**4.5.6 MATERIAL QUALIFICATION**

**4.5.6.1 TENSILE TESTING SPECIMENS.** Tensile test specimens shall be recovered from a Qualification Test Coupon (QTC) as described in Section 4.7. This QTC shall be used to qualify a heat and the products produced from that heat.

**4.5.6.2 TENSILE TESTING METHODS.** Tensile tests shall be performed at room temperature in accordance with the procedures specified in ASTM A 370.

A minimum of one tensile test shall be performed. The results of the tensile test(s) shall satisfy the applicable requirements of Section 4.5. If the results of the first tensile tests do not satisfy the applicable requirements, two additional tensile tests may be performed in an effort to qualify the material. The results of each of these additional tests shall satisfy the requirements.

**4.5.6.3 IMPACT TEST SAMPLING.** Impact testing shall be performed on each heat of material used for pressure containing parts.

**4.5.6.4 IMPACT TEST SPECIMENS.** Impact test specimens shall be removed from a QTC as prescribed in Section 4.7. This QTC shall be used to qualify a heat and the products produced from that heat.

Standard size specimens, 10 x 10 mm in cross section, shall be used except where there is insufficient material. In this case the next smaller standard size specimen obtainable shall be used. When it is necessary to prepare sub-size specimens, the reduced dimension shall be in the direction parallel to the base of the V-Notch.

**4.5.6.5 IMPACT TEST METHODS.** Impact tests shall be performed in accordance with the procedures specified in ASTM A 370 using the Charpy V-Notch technique. To qualify material for a temperature rating the impact tests shall be performed at or below the test temperature shown in Table 4.5.6.7.

A minimum of three impact specimens shall be tested to qualify a heat of material. Impact property average shall be the minimum shown in Table 4.5.6.7. In no case shall an individual impact value fall below 2/3 the minimum average. No more than one of the three test results may be below the required minimum average. If a test fails, then one retest of three additional specimens (recovered from the same location within the same QTC with no additional heat treatment) may be made. The retest shall exhibit an impact value equal to or exceeding the required minimum average.

**4.5.6.6 SPECIMEN ORIENTATION.** The values listed in Table 4.5.6.7 are the minimum acceptable values for forgings and wrought products tested in the transverse direction and for castings and weld qualifications. Forgings and wrought products may be tested in the longitudinal direction instead of the transverse direction and then shall exhibit 20 ft-lbs minimum average impact value.

**TABLE 4.5.6.7**  
**ACCEPTANCE CRITERIA CHARPY V-NOTCH IMPACT REQUIREMENTS**

Temperature Rating	Test Temperature °F (°C)	Minimum Average Impact Value For 3 Specimens ft-lb. (J)	Minimum Impact Value For 1 Specimen ft-lb. (J)
A	- 4 (-20)	15 (20,3)	10 (13,5)
B	- 4 (-20)	15 (20,3)	10 (13,5)
K	-75 (-60)	15 (20,3)	10 (13,5)
P	-20 (-29)	15 (20,3)	10 (13,5)
U	0 (-18)	15 (20,3)	10 (13,5)

**4.6 RIGID PIPING.** Rigid piping shall meet the material requirements of Section 4.5.1, Table 4.5.2, Table 4.5.3 and and Section 4.5.5.

**4.7 QUALIFICATION TEST COUPONS.** The properties exhibited by the qualification test coupon (QTC) represent the properties of the material comprising the equipment it qualifies. A single QTC may be used to represent the impact and/or tensile properties of components produced from the same heat provided it satisfies the requirements of this specification.

When the QTC is a trepanned outlet or a prolongation removed from a part, the QTC will only qualify parts that are identical in size and shape to the part from which it was removed. When the QTC is a sacrificial part, it qualifies only parts having identical size and shape.

A QTC will only qualify material and parts produced from the same heat. Remelt heat may be qualified on a master heat basis.

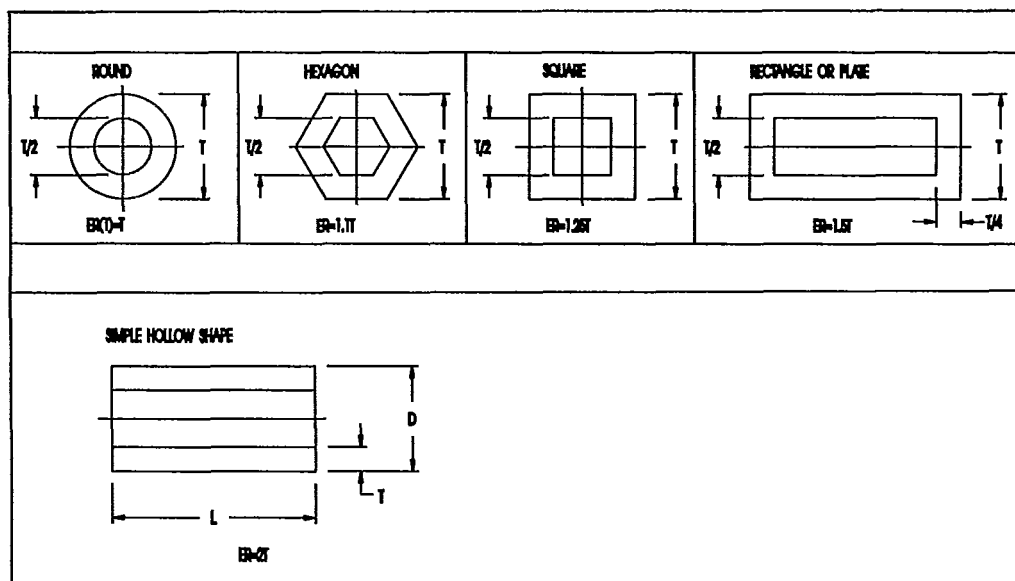
**4.7.1 EQUIVALENT ROUND METHODS.** The size of a QTC for a part shall be determined using the following Equivalent Round (ER) method:

Figure 4.7.1.2 and Figure 4.7.1.3 illustrate the basic models for determining the ER of simple solid and hollowed parts and more complicated equipment. The ER of a part shall be determined using the actual dimensions of the part in the "as heat treated" conditions.

The ER of a studded type part shall be determined by using T equal to the thickness of the thickest flange of that part. ER determination for these parts shall be in accordance with the methods for complex shaped parts.

**4.7.1.1 SIZE REQUIREMENTS.** The ER of the QTC shall be equal to or greater than the dimensions of the part it qualifies, except the size is not required to exceed 5 inches (125 mm) ER.

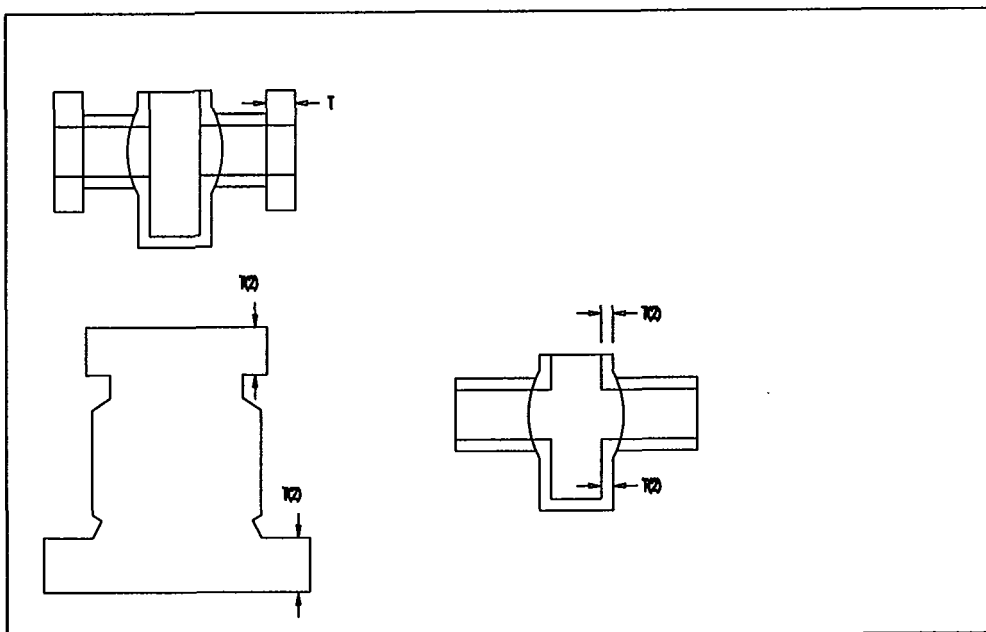
**FIGURE 4.7.1.2**  
**SIMPLE GEOMETRIC SHAPES**



When L is less than T, consider section as a plate of L thickness.  
Area inside of dashed lines is 1/4 T envelope for test specimen removal.  
When L is less than D, consider as a plate of T thickness.

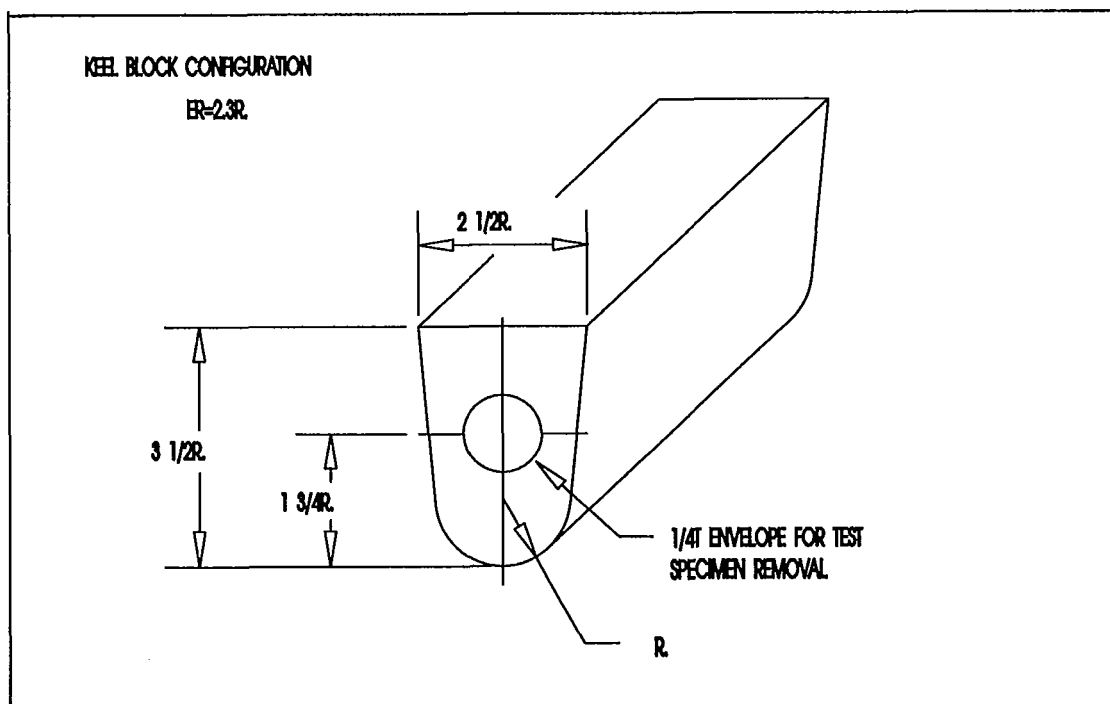
**FIGURE 4.7.1.3**  
**COMPLEX-SHAPED COMPONENTS**

This Equivalent Round Model is for general flanged bodies for complex-shaped components.



When internal and external surfaces during the heat treatment are within 1/2 inch (13 mm) the final surfaces,  $ER = 1 \frac{1}{4} T$ .  
 When internal and external surfaces during the heat treatment are not within 1/2 inch (13 mm) the final surfaces,  $ER = 2 T$ .  
 On multiflanged components,  $T$  shall be the thickness of the thickest flange.  
 $T$  = thickness when the component is heat treated.  
 $ER$  = equivalent round  
 (2) use the largest dimension

**FIGURE 4.7.1.4**  
**KEEL BLOCK CONFIGURATION**



**4.7.2 MELTING, CASTING AND HOT WORKING**

**4.7.2.1 MELTING PRACTICES.** The QTC shall be processed using a melting practice cleaner than that of the material it qualifies (e.g., a QTC shall not be made from a remelt grade or vacuum degassed material may not qualify material from the same primary melt which has not experienced the identical melting practice). Remelt grade material removed from a single remelt ingot may be used to qualify other remelt grade material which has been processed in like manner and is from the same melt. No additional alloying shall be performed on these individual remelt ingots.

**4.7.2.2 CASTING PRACTICES.** The manufacturer shall use the same foundry practices for the QTC as those used for the parts it qualifies.

**4.7.2.3 HOT WORKING PRACTICES.** The manufacturer shall use hot working ratios on the QTC which are equal to or less than those used in processing the part it qualifies. The total hot work ratio for the QTC shall not exceed the total hot work ratio of the parts it qualifies.

**4.7.2.4 WELDING.** Welding on the QTC is prohibited except for attachment type welds.

**4.7.2.5 HEAT TREATMENT EQUIPMENT QUALIFICATION.** Heat treatment operations shall be performed utilizing "production type" equipment qualified in accordance with the manufacturer's written specification. "Production Type" heat treating

equipment shall be considered equipment that is routinely used to process production parts.

**4.7.2.6 HEAT TREATMENT METHODS.** The QTC shall experience the same specified heat treatment procedure as the parts it qualifies. The QTC shall be heat treated using the manufacturer's written specification.

**4.7.3 TENSILE AND IMPACT TESTING**

**4.7.3.1 TEST SPECIMENS.** Tensile and impact test specimens shall be removed from the same QTC after the final QTC heat treatment cycle.

Tensile and impact specimens shall be recovered from the QTC such that their longitudinal center line axis is wholly within the center core 1/4 T envelope for a solid QTC or within 1/8 inch (3,2 mm) of the mid-thickness of the thickest section of a hollow QTC, reference Figure 4.7.1.2, Figure 4.7.1.3, and Figure 4.7.1.4.

When a sacrificial production part is used as a QTC, the impact and tensile test specimens shall be recovered from the 1/4 T location of the thickest section in that part.

**4.7.4 HARDNESS TESTING.** A minimum of two Brinell hardness tests shall be performed on the QTC after the final heat treatment cycle. Hardness Testing shall be performed in accordance with procedures specified in Section 6.

## SECTION 5 WELDING

Welding requirements are established in four groups:

1. Non-Pressure Containing Weldments (except for overlay)
2. Pressure Containing Fabrication Weldments — Bodies, Bonnets, and End and Outlet Connections
3. Pressure Containing Repair Weldments — Bodies, Bonnets, and End and Outlet Connections
4. Weld Overlay

**5.1 NON-PRESSURE CONTAINING WELDMENTS.** This Section covers non-pressure containing weldments other than those used in weld overlay, which are covered in Section 5.4.

**5.1.1 WELDING PROCEDURE/PERFORMANCE.** Welding procedures and performance qualifications shall be per Articles II and III of ASME Section IX.

**5.1.2 APPLICATION.** Welding shall be performed in accordance with qualified procedures by qualified welding personnel. Weld joint types and sizes shall meet the manufacturer's written design requirements.

**5.1.3 QUALITY CONTROL REQUIREMENTS.** Welding and completed welds shall meet the requirements of Section 6.

**5.2 PRESSURE CONTAINING FABRICATION WELDMENTS.** Pressure containing fabrication weldments for bodies, bonnets, end connections and outlet connections are covered in this Section.

**5.2.1 JOINT DESIGN.** Design of groove and fillet welds with tolerances shall be documented in the manufacturer's specifications. The Appendix of this specification, provides recommended weld groove designs.

### 5.2.2 MATERIALS

**5.2.2.1 WELDING CONSUMABLES.** Welding consumables shall conform to AWS or manufacturer's written specifications. The manufacturer shall have a written procedure for storage and control of welding consumables. Materials of low hydrogen type shall be stored and used as specified by consumable manufacturer to retain their original low hydrogen properties.

**5.2.2.2 DEPOSITED WELD METAL PROPERTIES.** The deposited weld metal mechanical properties as determined by the procedure qualification record (PQR), shall meet or exceed the minimum specified mechanical properties for the base material.

### 5.2.3 WELDING PROCEDURE QUALIFICATION

**5.2.3.1 WRITTEN PROCEDURE.** Welding shall be performed in accordance with welding procedure specifications (WPS) written and qualified in accordance with Article II of ASME, Section IX. The WPS shall describe the essential, non-essential and supplementary essential (when required — see ASME, Section IX) variables.

The PQR shall record essential and supplementary essential (when required) variables of the weld procedure used for the qualification test(s). Both the WPS and PQR shall be maintained as records in accordance with the requirements of Section 6.5.

**5.2.3.2 BASE METAL GROUPINGS.** A WPS for each material which is not listed in an ASME Section IX P-number grouping shall be specifically qualified for the manufacturer's specified base material.

**5.2.3.3 HEAT TREAT CONDITION.** Testing shall be done with the test weldment in the post-weld heat-treated condition.

**5.2.3.4 HEAT TREATMENT.** The post-weld heat treatment of the test weldment shall be in the same temperature range as that specified on the WPS. Allowable range for the post-weld heat treatment on the WPS shall be a nominal temperature range  $\pm 25^{\circ}\text{F}$  ( $\pm 4^{\circ}\text{C}$ ).

**5.2.4 POST WELD HEAT TREATMENT, LOCAL HEATING.** Local post weld heat treatment shall consist of heating a circumferential band around the weld at a temperature within the ranges specified in the qualified welding procedure specification. The minimum width of the controlled band at each side of the weld on the face of the greatest weld width shall be the thickness of the weld or 2 inches from the weld edge, whichever is less. Heating by direct flame impingement on the material shall not be permitted.

**5.2.4.1 IMPACT TESTING.** One set of 3 test specimens each shall be removed at the 1/4 thickness location of the test weldment for each of the weld metal and base material HAZ. The root of the notch shall be oriented normal to the surface of the test weldment and located as follows:

1. Weld Metal Specimens (3 each) 100% weld metal.

2. HAZ Specimens (3 each) include as much HAZ material as possible. Results of testing in the weld and base material HAZ shall meet the minimum requirements of the base material. Records of results shall become part of the PQR. Any retest of impact testing shall be in accordance with ASTM A 370.

**5.2.4.2 CHEMICAL ANALYSIS.** Chemical analysis of the base materials and filler metal for the test weldment shall be obtained from the supplier or by testing, and shall be part of the PQR.

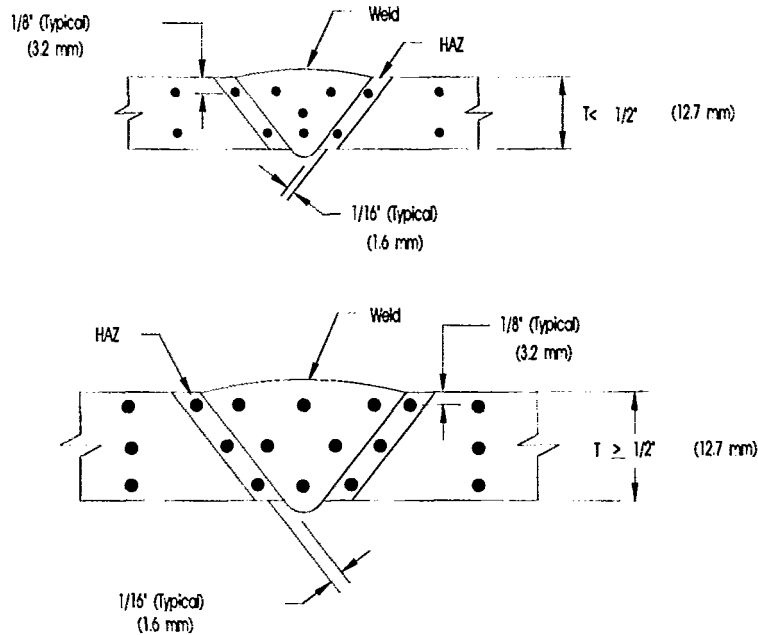
**5.2.4.3 HARDNESS TESTING.** Hardness testing shall be in accordance with Section 5.2.4.3.1 or Section 5.2.4.3.3.

**5.2.4.3.1 Rockwell Method.** The Rockwell Method shall be in accordance with ASTM E 18. Test locations shall be as shown in Figure 5.2.4.3.2. For a weld cross section thickness less than 1/2 inch (12,7 mm), four hardness tests each shall be made in the base material(s), the weld, and the HAZ. For a weld

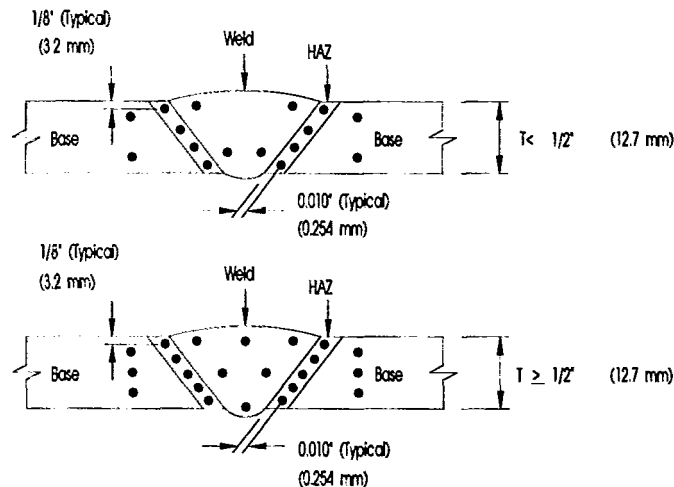
cross section thickness equal to or greater than 1/2 inch (12,7 mm), six hardness tests each shall be made in the base material(s), the weld, and the HAZ.

For all thicknesses, HAZ hardness tests shall be performed in the base material with 1/16 inch (1,6 mm) of the weld interface and at least one each within 1/8 inch (3,2 mm) from top and bottom of the weld.

**5.2.4.3.3 Vickers 10 Kg Method.** The Vickers method shall be in accordance with ASTM E 92. Test locations shall be as shown in Figure 5.2.4.3.4. For a weld cross section thickness less than 1/2 inch (12,7 mm), four hardness tests each shall be made in the base material(s) and the weld. For a weld cross section thickness equal to or greater than 1/2 inch (12,7 mm), six hardness tests each shall be made in the base material(s) and the weld.



**FIGURE 5.2.4.3.2  
WELDING PROCEDURE QUALIFICATION  
ROCKWELL HARDNESS TEST LOCATIONS**



**FIGURE 5.2.4.3.4  
WELDING PROCEDURE QUALIFICATION  
VICKERS HARDNESS TEST LOCATION**



**5.2.4.4 WELDING CONTROLS.** Instruments, meters and gauges used to verify welding parameters shall be serviced and calibrated in accordance with Section 6.1.

**5.2.4.5 APPLICATION.** The post-weld heat treatment of the production weldment shall be in the same temperature range as that specified on the WPS. The stress relieving heat treatment time(s) at temperature of production parts shall be equal to or greater than that of the test weldment.

**5.2.5 QUALITY CONTROL REQUIREMENTS.** Requirements for pressure containing welds are shown in Section 6.

**5.3 PRESSURE CONTAINING REPAIR WELDMENTS.** Repair welding procedures for bodies, bonnets, end connections and outlet connections shall define the WPS and NDE requirements. Welding shall be performed in accordance with the specified WPS.

**5.3.1 BASE MATERIAL.** The base material requirements for material composition, API material designation, impact toughness and heat treatment condition shall be known prior to selecting a qualified WPS.

**5.3.2 FUSION.** The WPS selected for repair shall ensure complete fusion.

**5.3.3 PQR.** The WPS selected shall be supported by a PQR as described in Section 5.2.3.

**5.3.4 ACCESS.** There shall be adequate access to evaluate, remove, repair and inspect the nonconforming condition.

**5.3.5 WELDER/WELDING OPERATOR QUALIFICATION.** The welder/welding operator shall possess a valid qualification for the materials and processes to be used in accordance with Section 6.

**5.3.6 HOLE REPAIR — PERFORMANCE QUALIFICATION.** Bolt hole, tapped hole, and machined blind hole repair performance qualification shall be in accordance with this Section. The welder/welding operator shall perform an additional repair welding performance qualification test using a mock-up hole.

The repair welding qualification test hole shall be qualified by radiography in accordance with Section 6 or shall be cross sectioned through the center line of the hole in two places 90 degrees apart and macro etched to verify complete fusion. One surface of each of the four matching pairs shall be macro etched. This evaluation shall include the total depth of the hole.

The repair weld qualification shall be restricted by the following essential variables for performance controls:

1. The hole diameter used for the performance qualification test is the minimum diameter qualified. Any hole with a greater diameter than the diameter used for the test shall be considered qualified.

2. The depth-to-diameter ratio of the test hole shall qualify repairs to holes with the same or smaller depth-to-diameter ratio.

3. The performance qualification test hole shall have straight parallel walls. If any taper, counterbore or other aid is used to enhance the hole configuration of the

performance test, that configuration shall be considered an essential variable.

**5.4 WELD OVERLAY.** Weld overlays for corrosion resistance and/or hard facing and other material surface property controls are covered in this Section.

**5.4.1 RING GROOVES.** This section applies to loose connectors, and integral end and outlet connections.

**5.4.1.1 Chemical Analysis.** Chemical analysis shall be performed in the weld metal in accordance with the requirements of ASME, Section IX at a location of 0.125 inches (3,2 mm) or less from the original base metal surface. The chemical composition of the deposited weld metal at that location shall be as specified by the manufacturer. 300 Series stainless steel chemical composition shall be:

Nickel	8.0 %	Minimum
Chromium	6.0 %	Minimum
Carbon	0.08%	Maximum

#### 5.4.1.2 APPLICATION

**5.4.1.2.1 Post Weld Heat Treatment.** End and outlet connections with corrosion resistant weld overlaid ring grooves shall be subjected to post weld heat treatment in accordance with the weld procedure qualification.

**5.4.1.2.2 API Grooves.** API grooves for welding shall be prepared in accordance with API Specification 6A, Section 901.

**5.4.1.2.3 Other Weld Preparations.** Other weld preparations may be used where the mechanical properties of the deposited weld metal equals or exceeds that of the base metal.

**5.4.1.3 HARDNESS TESTING FOR RING GROOVE OVERLAY.** Hardness testing shall be performed in the weld metal as part of the procedure qualification testing. Test locations shall be within 0.125 inch (3,2 mm) of the original base material. The average of 3 or more test results shall be equal to or greater than Rockwell B 83 and recorded as part of the PQR.

**5.4.2 OTHER CORROSION RESISTANT OVERLAY.** This section applies to use of corrosion resistant weld overlay for bodies, bonnets, and end and outlet connectors for purposes other than ring grooves. These requirements do not apply to hard facing or to the weld overlay of valve bore sealing mechanisms or of valve stems.

**5.4.3 WELDING PROCEDURE/PERFORMANCE QUALIFICATION.** Qualification shall be in accordance with Article II and III of ASME, Section IX, for weld overlay, hard facing, or other types of overlay as applicable.

**5.4.3.1 CHEMICAL ANALYSIS.** Chemical analysis shall be performed in the weld metal in accordance with the requirements of ASME Section IX at the minimum overlay thickness as specified for the finished component.

The chemical analysis of the overlay shall conform to the manufacturer's written specification.

**5.4.3.2 MECHANICAL PROPERTIES.** Mechanical properties of the base material shall retain the minimum mechanical property requirements after post weld heat treatment. The manufacturer shall specify the methods to assure these mechanical properties and record the results as part of the PQR.

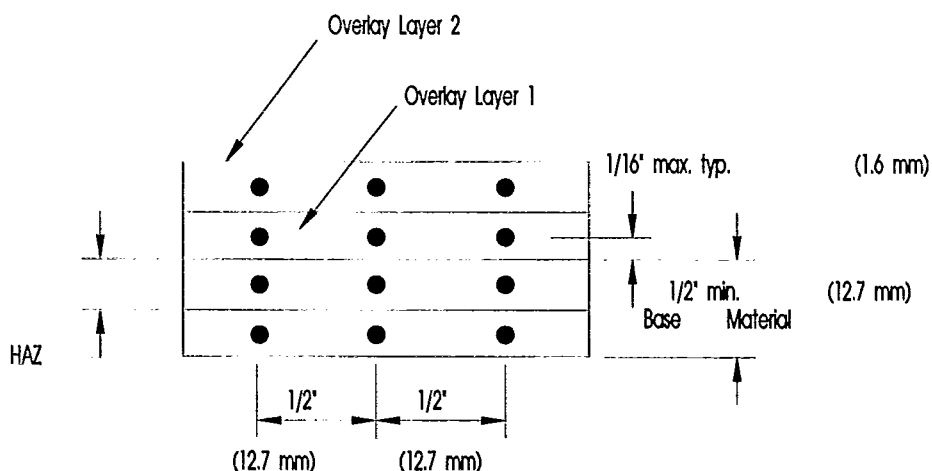
**5.4.3.3 OVERLAY MECHANICAL PROPERTIES.** Overlay materials considered a part of the minimum wall thickness shall have a tensile and Charpy test. These tests shall confirm that the overlay material properties meet or exceed the base material properties.

**5.4.3.4 WELD CONFORMANCE TO NACE STANDARD MR0175-91.** Welds shall conform to the requirements of Section and NACE Standard MR0175-91.

**5.4.3.5 HARDNESS TESTING.** When the welding procedure is to be qualified for use on bodies, bonnets, or flanges hardness testing shall be as per Section 5.2.4.3. Hardness tests shall be performed at a minimum of three test locations each: in the base material, in the heat affected zone, and in each layer of overlay up to a maximum of two layers. See Figure 5.4.3.6.

**5.4.3.7 GUIDED BEND TESTS.** Guided bend tests and acceptance criteria shall be in accordance with ASME Section IX to verify weld overlay/base material bond integrity.

**5.4.3.8 BASE MATERIAL CONFORMANCE TO NACE STANDARD MR0175-91.** The base material shall conform to NACE Standard MR0175-91 after weld overlay and any subsequent heat treatments.



**FIGURE 5.4.3.6  
HARDNESS TEST LOCATIONS**

## SECTION 6

### QUALITY CONTROL

This section specifies the quality control and quality control record requirements for Choke and Kill Systems, equipment and material manufactured to meet this specification.

**6.1 MEASURING AND TESTING 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's instructions, and in compliance with referenced industry standards, to maintain the accuracy required by this specification.

**6.1.1 MEASUREMENT STANDARDS AND MEASURING EQUIPMENT.** Measurement standards and measuring equipment shall be controlled and calibrated to maintain accuracies within the limits specified by the measuring equipment manufacturer or the manufacturer's written procedure.

**6.1.1.1 MEASUREMENT EQUIPMENT MARKINGS.** After receipt and prior to being placed in service, each piece of measuring equipment (gauge) will be verified to have a permanent unique identification. If no identification exists, the manufacturer shall apply one. The manufacturer may also choose to apply additional unique identification to comply with the manufacturer's written specifications. The method of application of the identification shall be such that it will not affect the accuracy of the gauge. In the event that the identification cannot be applied directly to the gauge, it may be applied to a tag affixed to the gauge or the gauge container.

**6.1.1.2 MEASURING EQUIPMENT RECORDS.** The manufacturer shall maintain individual records of measurement standards and equipment as described below in items 1 through 7. Measure standards and measuring equipment used for high accuracy measurements require the additional data in items 8 and 9.

1. Unique identification of measurement standard or equipment.
2. Identification of measurement standard equipment and calibration procedure utilized in the calibration process.
3. Planned calibration interval.
4. Date and results of each calibration including actual readings taken prior to adjustment, corrections or repairs.
5. Interval when due for next calibration.
6. Individual performing calibration and facility performing calibration.
7. Assigned location.

When appropriate the following additional information shall be provided:

8. The environmental conditions for calibration and the measurement data as measured and as corrected to reference standards.
9. Details of any maintenance, servicing, adjustment, repairs, or modification which could affect the calibration status.

**6.1.1.3 ADEQUACY OF MEASUREMENT STANDARDS.** Measurement standards and procedures used to calibrate measuring equipment shall be evaluated by the manufacturer to assure that any random and systematic errors in calibration do not exceed 25% of the tolerance of the parameter being measured. Measuring equipment requiring high levels of accuracy which approach state of the art or natural physical constant limitations would be excluded from this requirement.

**6.1.1.4 CALIBRATION INTERVALS.** Measurement standards and measuring equipment shall be calibrated at intervals established by the manufacturer that take into consideration such factors as stability, purpose, and degree of usage. Intervals shall be shortened or lengthened as required to assure continued accuracy and stability as evidenced by the results of previous calibrations.

**6.1.1.5 CALIBRATION LABELING.** Measurement standards and measuring equipment shall be labeled, coded or otherwise identified to indicate the calibration status. Any limitation or restriction of use shall be clearly indicated on the equipment. When neither labeling or coding is practical, other methods as defined by the manufacturer's written procedure shall be used.

#### 6.1.2 PRESSURE MEASURING DEVICES

**6.1.2.1 TYPE AND ACCURACY.** Test pressure measuring devices shall be either pressure gauges or pressure transducers and shall be accurate to at least  $\pm 0.5\%$  of full scale range.

**6.1.2.2 RANGE.** Pressure measurements shall be made at not less than 25% nor more than 75% of the full pressure range of the pressure gauge.

**6.1.2.3 CALIBRATION PROCEDURE.** Pressure measuring devices shall be recalculated with a master pressure measuring device or a dead weight tester at 25%, 50% and 75% of full scale.

**6.1.2.4 CALIBRATION INTERVALS.** Calibration intervals shall be established based on repeatability and degree of usage. Intervals may be lengthened and shall be shortened based on recorded calibration history.

Calibration intervals shall be maximum of three months until a recorded calibration history can be established by the manufacturer.

#### 6.2 QUALITY CONTROL PERSONNEL QUALIFICATIONS

**6.2.1 NONDESTRUCTIVE EXAMINATION (NDE) PERSONNEL.** NDE Personnel shall be qualified in accordance with the requirements specified in SNT-TC-1A, Personnel Qualification and Certification in Non-destructive Testing.

**6.2.2 WELDING INSPECTORS.** Personnel performing visual inspection of welding operations and completed welds shall be qualified and certified as follows:

1. AWS certified welding inspector, or

2. AWS certified associate welding inspector, or

3. Welding inspector certified by the manufacturer's documented training program.

**6.2.3 OTHER PERSONNEL.** Personnel performing other quality control activities directly affecting material or product quality shall be qualified in accordance with manufacturer documented requirements.

### 6.3 QUALITY CONTROL REQUIREMENTS

**6.3.1 GENERAL.** Tables have been included in this Section that provide a matrix of quality control requirements for specific parts and equipment.

**6.3.2 MATERIALS.** Section 4 includes detailed qualification requirements for parts and qualification test coupons.

Quality control testing or examination shall be performed on parts in contact with well fluids to verify that NACE Standard MR0175 values and requirements have been satisfied. If the other requirements of this Section satisfy this requirement, additional testing or examination is not required.

**6.3.3 QUALITY CONTROL INSTRUCTIONS.** Quality control activities shall be controlled by manufacturer's documented instructions that shall include appropriate methodology and quantitative or qualitative acceptance criteria.

**6.3.4 NONDESTRUCTIVE EXAMINATION (NDE).** Nondestructive examination (NDE) instructions shall be detailed regarding the requirements of this Specification and those of applicable referenced standards. All NDE instructions shall be approved by a Level III individual.

**6.3.5 ACCEPTANCE STATUS.** The acceptance status of 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.

### 6.3.6 BODIES, BONNETS AND END AND OUTLET CONNECTIONS

**TABLE 6.3.6.1  
QUALITY CONTROL REQUIREMENTS FOR  
BODIES, BONNETS AND END AND OUTLET  
CONNECTIONS**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Hardness Testing	6.3.6.4
Dimensional Verification	6.3.6.5
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7
Visual Examination	N/A
Surface NDE	6.3.6.9
Volumetric NDE	6.3.6.10
Serialization	6.3.6.13
Weld NDE - General	6.3.6.11
- Visual Examination	6.3.6.11.1
- Surface NDE	6.3.6.11.2
- Volumetric NDE	6.3.6.11.3
- Hardness Testing	6.3.6.11.4
- Repair Welds	6.3.6.12

**6.3.6.2 TENSILE TESTING.** Tensile testing requirements shall be per Section 4.

**6.3.6.3 IMPACT TESTING.** Impact testing requirements shall be per Section 4.

**6.3.6.4 HARDNESS TESTING.** Hardness testing shall be performed with procedures specified in ASTM E 10.

At least one hardness test shall be performed on each finished part, with additional tests on each end connection face at locations specified in the manufacturer's design documents.

The hardness testing used to qualify each part shall be performed after the last heat treatment cycle (including stress relieving heat treatment cycles) and after exterior machining operations.

When equipment is composed of bodies and flanges having different API material designations, the manufacturer shall perform hardness tests on each part. The results of these hardness tests shall satisfy the hardness value requirements for each respective part.

**6.3.6.4.1 Acceptance Criteria.** Hardness measurements on parts fabricated from carbon, low alloy and martensitic stainless type steels shall exhibit hardness values equal to or greater than Table 6.3.6.4.2. See NACE Standard MR0175 for maximum hardness values.

**TABLE 6.3.6.4.2  
MINIMUM HARDNESS VALUES**

API MATERIAL DESIGNATIONS	BRINELL HARDNESS NUMBER
36 ksi	HB 140
45 ksi	HB 140
60 ksi	HB 174
75 ksi	HB 197

In the event that a part does not exhibit the required minimum hardness value, the part may be considered to have an acceptable hardness if the measured value satisfies the requirements of the following paragraph.

The average tensile strength, as determined from the tensile tests results, shall be used with the hardness measurements in order to determine the minimum acceptable hardness value for production parts fabricated from the same heat. The minimum acceptable hardness value for any part shall be determined by:

$$HB_C = \frac{UTS}{UTS_{QTC}} HB_{QTC}$$

where:

$HB_C$  = Minimum acceptable Brinell hardness for a part after the final heat treatment cycle (including stress relieving cycles)

$UTS$  = Minimum acceptable ultimate tensile for the applicable strength level, i.e. 70,000, 85,000 or 95,000 psi.

$UTS_{QTC}$  = Average ultimate tensile strength determined from the QTC tensile tests.

$HB_{QTC}$  = Average Brinell hardness values observed among the tests performed on the QTC

In the event that it is necessary to report the hardness test results in other measurement units, conversions shall be made in accordance with ASTM E 140: Standard Hardness Conversion Tables for Metals.

**6.3.6.5 DIMENSIONAL VERIFICATION.** Dimensional verification requirements shall be as follows, with verification being performed on all parts.

**6.3.6.5.1 Sampling.** End and outlet connection threads shall be gauged.

**6.3.6.5.2 Methods.** Threaded end and outlet connections shall be gauged for standoff at hand tight assembly by the use of the gauges and gauging of API Specification 6A, Section 902.

**6.3.6.5.3 Acceptance Criteria.** Acceptance Criteria shall be in accordance with API Specification 5CT or 5L or ANSI B 1.1 or B 1.2 as applicable.

**6.3.6.5.4 Critical Dimensions.** The manufacturer shall specify and verify critical dimensions. Acceptance criteria for critical dimensions shall be as required by the manufacturer's written specification.

**6.3.6.6 TRACEABILITY.** Parts shall be traceable to the individual heat and heat treatment lot. Identification shall be maintained on materials and parts, to facilitate traceability, as required by documented manufacturer specifications.

Manufacturer's documented traceability requirements shall include provisions for maintenance or replacement of identification marks and identification records.

### 6.3.6.7 CHEMICAL ANALYSIS

**6.3.6.7.1 Sampling.** Chemical analysis shall be performed on a heat basis.

**6.3.6.7.2 Methods.** Chemical analysis shall be performed in accordance with a recognized industry standard specified by the manufacturer.

**6.3.6.7.3 Acceptance Criteria.** The chemical composition shall meet the requirements of Section 4 and the manufacturer's written specification.

**6.3.6.8 VISUAL EXAMINATION.** No visual examination is required.

**6.3.6.9 SURFACE NDE.** Surface NDE requirements shall be as follows:

Accessible surfaces of each finished part shall be examined after final heat treatment and final machining operations.

All magnetic particle examinations shall use the wet fluorescent method.

Surface NDE shall be performed on all surfaces prepared for weld overlay.

**6.3.6.9.1 Surface NDE — Ferromagnetic Materials.** All ferromagnetic materials shall be examined in accordance with procedures specified in ASTM E 709. Prods are not permitted on well fluid surfaces or sealing surfaces.

**6.3.6.9.1.1 Relevant Indication.** Only those indications with major dimensions greater than 1/16 inch shall be considered relevant.

Inherent indications not associated with a surface rupture (i.e., magnetic permeability variations,

non-metallic stringers...) are considered non-relevant.

If indications are believed to be non-relevant, they shall be examined by liquid penetrant surface NDE methods as per ASTM E 165, or removed and reinspected, to prove their non-relevancy.

**6.3.6.9.1.2 Linear Indication.** Indication in which the length is equal to or greater than three times its width.

**6.3.6.9.1.3 Rounded Indication.** Indication which is circular or elliptical with its length less than 3 times the width.

#### 6.3.6.9.1.4 Acceptance Criteria

1. No relevant indication with a major dimension equal to or greater than 3/16 inch.

2. No more than ten relevant indications in any contiguous 6 inches square area.

3. Four or more relevant indications in a line separated by less than 1/16 inch (edge to edge) are unacceptable.

4. No relevant indications in the pressure contact sealing surfaces.

**6.3.6.9.2 Surface NDE — Non-ferromagnetic Materials.** All non-ferromagnetic materials shall be examined in accordance with procedures specified in ASTM E 165. The definitions of Sections 6.3.6.9.1.1, 6.3.6.9.1.2 and 6.3.6.9.1.3 are applicable.

#### Acceptance Criteria:

1. No relevant linear indications.

2. No relevant rounded indication with a major dimension equal to or greater than 3/16 inch.

3. Four or more relevant rounded indications in a line separated by less than 1/16 inch (edge to edge) are unacceptable.

4. No relevant indications in pressure contact sealing surfaces.

### 6.3.6.10 VOLUMETRIC NDE

**6.3.6.10.1 Sampling.** As far as practical the entire volume of each part shall be volumetrically inspected (radiography or ultrasonic) after heat treatment for mechanical properties (exclusive of stress relief treatments) and prior to machining operations that limit effective interpretation of the results of the examination.

#### 6.3.6.10.2 Method — Ultrasonic Examination

**6.3.6.10.2.1 Hot Worked Parts.** Ultrasonic examination of hot worked parts shall be performed in accordance with the flat bottom hole procedures specified in ASTM A 388 (except immersion method may be used) and ASTM E 428.

**6.3.6.10.2.2 Castings.** Ultrasonic examinations of castings shall be performed in accordance with the flat bottom hole procedures specified in ASTM A 609 (except immersion method may be used) and ASTM E 428.

**6.3.6.10.2.3 Calibration.** Distance amplitude curve (D.A.C.) shall be based on a 1/16 inch flat bottom hole for metal thicknesses through 1 1/2 inches, 1/8 inch flat bottom hole for metal thick-

nesses from 1 1/2 inches through 6 inches and 1/4 inch flat bottom hole for metal thicknesses exceeding 6 inches.

**6.3.6.10.2.4 Acceptance Criteria.** No single indications exceeding reference distance amplitude curve.

No multiple indications exceeding 50% of reference distance amplitude curve. Multiple indications are defined as two or more indications (each exceeding 50% of the reference distance amplitude curve) within 1/2 inch of each other in any direction.

**6.3.6.10.3 Method — Radiographic Examination.** Radiographic examinations shall be performed in accordance with procedures specified in ASTM E 94, to a minimum equivalent sensitivity of 2%. Both X-ray and gamma ray radiation sources are acceptable within the inherent thickness range limitation of each. Real time imaging and recording/enhancement methods may be used when the manufacturer has documented proof that the methods will result in a minimum equivalent sensitivity of 2%. Wire type image quality indicators are acceptable for use per ASTM E 747.

**TABLE 6.3.6.10.3.1  
HOT WORKED PARTS  
ACCEPTANCE CRITERIA**

No cracks, laps, or bursts.

No elongated indications with length greater than:

THICKNESS (T) inches	INCLUSION LENGTH inches
Less than 0.76	0.25
0.76 to 2.25y	0.33T
>2.25	0.75

where T is the pressure vessel wall thickness.

No group of indications in a line that have an aggregate length greater than T in a length of 12T.

**TABLE 6.3.6.10.3.2  
CASTINGS ACCEPTANCE CRITERIA**

ASTM E 186: Standard Reference Radiographs for Heavy Wall (2 to 4 1/2 inch) Steel Castings.

ASTM E 280: Standard Reference Radiographs for Heavy Wall (4 1/2 to 12 inch) Steel Castings.

ASTM E 446: Standard Reference Radiographs for Steel Castings Up to 2 inches thickness.

TYPE DEFECT	MAXIMUM DEFECT CLASS
A	2
B	2
C	2 (All Types)
D	None Acceptable
E	None Acceptable
F	None Acceptable
G	None Acceptable

**6.3.6.11 WELD NDE.** When examination is required, essential welding variables and equipment shall be monitored and in process welding shall be audited. Completed weldments (a minimum of 1/2 inch of surrounding base metal and the entire accessible weld) shall be examined in accordance with the methods and acceptance criteria of this Section. Requirements and acceptance criteria for corrosion resistant weld overlay of bodies, bonnets and flanges can be different from those for other weld types and shall meet the manufacturer's written specifications. The manufacturer's written specification for corrosion resistant weld overlay shall include a technique for measuring the specified overlay thickness.

#### **6.3.6.11.1 Weld Examination — Visual**

**6.3.6.11.1.1 Sampling.** Welds shall be visually examined for 100% of the length after post weld heat treatment and machining operations. Examinations shall include a minimum of 1/2 inch of adjacent base metal on both sides of the weld.

**6.3.6.11.1.2 Acceptance Criteria.** Pressure containing welds shall have complete joint penetration. Undercut shall not reduce the thickness in the area (considering both sides) to below the minimum thickness. Surface porosity and exposed slag are not permitted on or within 1/2 inch of sealing surfaces.

#### **6.3.6.11.2 Weld NDE — Surface**

**6.3.6.11.2.1 Sampling.** Each pressure containing fabrication weld or weld overlay shall be examined by either magnetic particle (in the case of ferrous materials) or liquid penetrant (in the case of non-ferrous materials) methods, after welding, post weld heat treatment and machining operations. Examinations shall include a minimum of 1/2 inch of adjacent base metal on both sides of the weld.

**6.3.6.11.2.2 Method.** Magnetic particle examination using the wet fluorescent method, shall be performed to procedures specified in ASTM E 709. Prods are not permitted on well fluid wetted surfaces or sealing surfaces.

Liquid penetrant examination shall be performed on accessible sealing surfaces of each finished part after final heat treatment and after final machining operations. Examination shall be performed as specified in ASTM E 165.

**6.3.6.11.2.3 Acceptance Criteria.** Acceptance criteria for weld surface examination shall be as described in Table 6.3.8.2 or Section 6.3.8.3 with the following additional requirements:

1. No relevant linear indications.

2. No rounded indications greater than 1/8 inch for welds whose depth is 5/8 inch or less; or 3/16 inch for welds whose depth is greater than 5/8 inch.

#### **6.3.6.11.3 Weld NDE — Volumetric**

**6.3.6.11.3.1 Sampling.** Pressure containing fabrication welds shall be examined by either radiog-

raphy or ultrasonic methods, after welding, post weld heat treatment and machining operations.

Repair welds, where the repair is greater than 20% of the original wall thickness or 1 inch (whichever is less) or where the extent of the cavity exceeds 10 square inches or where the casting leaks on hydrostatic test, shall be examined by either radiography or ultrasonic methods after welding, post weld heat treatment and machining operations.

Examination shall include at least 1/2 inch of adjacent base metal on all sides of the weld.

**6.3.6.11.3.2 Method — Radiographic Examination.** Radiographic examination of welds shall be performed in accordance with methods specified in Section 6.3.6.10.3.

**6.3.6.11.3.3 Acceptance Criteria.** No type of crack, zone of incomplete fusion or penetration.

No elongated inclusion which has a length equal to or greater than shown in Table 6.3.6.11.3.4.

**TABLE 6.3.6.11.3.4  
WELD INCLUSION LENGTH  
ACCEPTANCE CRITERIA**

THICKNESS (T) inches	INCLUSION LENGTH inches
Less than 0.76	0.25
0.76 to 2.25	0.33T
greater than 2.25	0.75

Where T is the pressure vessel wall thickness.

No elongated slag inclusion which has a length equal to or greater than the weld thickness (T) in any total weld length of 12T, except when the distance between successive inclusions exceeds six times the length of the longest inclusion.

No rounded indications in excess of that specified in ASME Boiler and Pressure Vessel Code, Section VIII, Division I, Appendix 4.

**6.3.6.11.3.5 Method — Ultrasonic Examination.** Ultrasonic examinations shall be performed in accordance with the procedures specified in ASME Boiler and Pressure Vessel Code, Section V, Article 5.

**6.3.6.11.3.6 Acceptance Criteria.** No indications whose signal amplitude exceeds the reference level.

No linear indications interpreted as cracks, incomplete joint penetration or incomplete fusion.

No slag indications with amplitudes exceeding the reference level whose length exceeds Table 6.3.6.11.3.7.

**TABLE 6.3.6.11.3.7  
WELD INCLUSION LENGTH  
ACCEPTANCE CRITERIA**

WELD THICKNESS (T)	INCLUSION LENGTH (inches)
Less than 0.76	0.25
0.76 to 2.25	0.33T
Greater than 2.25	0.75

#### **6.3.6.11.4 Weld NDE — Hardness Testing**

**6.3.6.11.4.1 Sampling.** Accessible pressure containing, nonpressure containing and repair welds shall be hardness tested.

**6.3.6.11.4.2 Methods.** Hardness testing shall be performed in accordance with one of the following:

Those procedures specified in ASTM E 10, Standard Test Methods for Brinell Hardness on Metallic Materials.

Those procedures specified in ASTM E 18, Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness on Metallic Materials.

At least one hardness test shall be performed in both the weld and in the adjacent unaffected base metal after heat treatment and machining operations.

**6.3.6.11.4.3 Acceptance Criteria.** Hardness values shall meet the base material requirements of Section 4. The hardness recorded on the PQR shall be the basis for acceptance if the weld is not accessible for hardness testing.

**6.3.6.12 REPAIR WELDS.** Repair welds shall be examined using the same methods and acceptance criteria as is used in examining the base metal or weld metal in the case of repair to a weld. Examinations shall include 1/2 inch of adjacent base metal on all sides of the weld. Surfaces prepared for welding shall be examined prior to welding to ensure defect removal to acceptable levels.

**6.3.6.13 SERIALIZATION.** Individual components and assemblies shall be assigned and marked with a unique code to maintain traceability and associated records. These records are specified in Section 6.5. Marking shall conform to Section 7.

**6.3.7 STEMS.** Table 6.3.7.1 lists the quality control requirements for stems.

**TABLE 6.3.7.1  
QUALITY CONTROL REQUIREMENTS  
FOR STEMS**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Hardness Testing	6.3.6.4
Dimensional Verification	6.3.6.5
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7
Visual Examination	N/A
Surface NDE	6.3.6.9
Volumetric NDE	6.3.6.10
Serialization	6.3.6.13
Weld NDE - General	6.3.6.11
- Visual Examination	6.3.6.11.1
- Surface NDE	6.3.6.11.2
- Volumetric NDE	6.3.6.11.3
- Hardness Testing	6.3.6.11.4
- Repair Welds	6.3.6.12

**6.3.7.2 VOLUMETRIC EXAMINATION**

**6.3.7.2.1 Sampling.** Each stem shall be ultrasonically inspected.

**6.3.7.2.2 Method.** Stems shall be examined in accordance with Section 6.3.6.10. Additionally, each stem shall be ultrasonically inspected from the outer diameter and by the straight beam technique. Stems which can not be examined axially using the straight beam technique shall be examined with a beam directed along the axis in both directions using the angle beam technique.

**6.3.7.2.3 Calibration.** Calibration shall be by distance amplitude curve based on a 1/8 inch flat bottom hole (straight beam technique) and a 1/16 inch side drilled hole, 1 inch deep (angle beam technique).

**6.3.7.2.4 Acceptance Criteria.** Acceptance criteria as per Section 6.3.6.10.

**6.3.8 PRESSURE CONTROLLING PARTS**

**6.3.8.1 PRESSURE CONTROLLING METALLIC PARTS.** Table 6.3.8.2 lists the quality control requirements for pressure controlling metallic parts.

**TABLE 6.3.8.2  
QUALITY CONTROL REQUIREMENTS FOR  
PRESSURE CONTROLLING METALLIC PARTS**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Hardness Testing	6.3.6.4
Dimensional Verification	6.3.6.5
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7
Visual Examination	N/A
Surface NDE	6.3.6.9
Volumetric NDE	6.3.6.10
Serialization	6.3.6.13
Weld NDE - General	6.3.6.11
- Visual Examination	6.3.6.11.1
- Surface NDE	6.3.6.11.2
- Volumetric NDE	6.3.6.11.3
- Hardness Testing	6.3.6.11.4
- Repair Welds	6.3.6.12

**6.3.8.3 PRESSURE CONTROLLING NON-METALLIC PARTS.** Pressure controlling non-metallic parts shall meet the requirements of the manufacturer's written specification.

**6.3.9 DRILLING CHOKE.** This section applies to drilling chokes.

**6.3.9.1 PRESSURE CONTAINING PARTS.** Pressure containing parts of drilling chokes are the Body, Bonnet, End and Outlet Connections and Stem.

Table 6.3.6.1 list the quality control requirements for the pressure containing parts of a drilling choke.

**6.3.9.2 PRESSURE CONTROLLING PARTS.** Pressure controlling parts of drilling chokes are parts such as the Disc, Plug, Gate or Needle and the Seat.

Table 6.3.8.2 lists the quality control requirements for the metallic pressure controlling parts of a drilling choke. Non-metallic pressure controlling parts shall meet the requirements of Section 6.3.8.3.

**6.3.10 ACTUATORS FOR DRILLING CHOKES.** This Section applies to hydraulically powered actuators for drilling chokes.

**6.3.10.1 PRESSURE CONTAINING PARTS.** Pressure containing parts of an actuator include the cylinder, cylinder closure, piston and stem.

**6.3.10.2 QUALITY CONTROL REQUIREMENTS.** Table 6.3.10.3 lists the quality control requirements for actuators.

**TABLE 6.3.10.3  
QUALITY CONTROL REQUIREMENTS FOR  
PRESSURE CONTAINING PARTS  
OF ACTUATORS**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7

**6.3.10.4 MATERIAL SPECIFICATIONS.** Metallic and non-metallic materials used in actuators exposed only to control fluids shall have written material specifications. The manufacturer's written specification shall define (as a minimum):

1. Mechanical Property Requirements
2. Chemical Composition
3. Heat Treatment Procedure
4. Impact Requirements in accordance with Table 4.5.6.7.

**6.3.10.5 TRACEABILITY.** Pressure containing parts of actuators having a minimum working pressure greater than 375 psig require material traceability. Traceability is considered sufficient when the part can be traced to a job lot which identifies the included heat lot(s). Components in a multiheat job shall be rejected if any heat lot does not comply with the manufacturer's written specifications. If heat lot traceability is maintained, only noncomplying heat lots need be rejected.

**6.3.11 NON-METALLIC SEALING MATERIAL**

**6.3.11.1 QUALITY CONTROL REQUIREMENTS.** Quality of non-metallic seals shall be controlled in accordance with Table 6.3.11.2.



**TABLE 6.3.11.2**  
**QUALITY CONTROL REQUIREMENTS**  
**NON-METALLIC SEALING MATERIAL**

QUALITY REQUIREMENT	SECTION
Dimensional Verification	6.3.11.3
Visual Examination	6.3.11.4
Hardness Testing	6.3.11.5
Documentation	6.3.11.6
Batch Traceability	6.3.13.4
Cure Date Certification	6.3.13.4
Shelf Life Expiration Date Certification	6.3.10.4

### 6.3.11.3 DIMENSIONAL VERIFICATION

**6.3.11.3.1 Sampling.** Sampling shall be performed on non-metallic seals in accordance with MIL-STD-105, Level II, 2.5 AQL for O-rings and 1.5 AQL for other seals.

**6.3.11.3.2 Method.** Each piece of the sample shall be dimensionally inspected for compliance to specific tolerances.

**6.3.11.3.3 Acceptance Criteria.** If inspection methods produce rejections less than allowed in sampling, the batch shall be accepted.

### 6.3.11.4 VISUAL EXAMINATION

**6.3.11.4.1 Sampling.** Sampling shall be performed in accordance with MIL-STD-105, Level II, 2.5 AQL for O-rings and 1.5 AQL for other seals.

**6.3.11.4.2 Method.** Each piece of the sample shall be visually inspected according to manufacturer's written requirements.

**6.3.11.4.3 Acceptance Criteria.** If inspection methods produce rejections less than that allowed, the batch shall be accepted.

### 6.3.11.5 HARDNESS TESTING

**6.3.11.5.1 Sampling.** Sampling shall be performed in accordance with MIL-STD-105, Level II, 2.5 AQL for O-rings and 1.5 AQL for other seals.

**6.3.11.5.2 Method.** Hardness testing shall be performed in accordance with procedures specified in ASTM D 2240 or D 1415.

**6.3.11.5.3 Acceptance Criteria.** The hardness shall be controlled in accordance with the manufacturer's written specification.

**6.3.11.6 DOCUMENTATION.** The supplier and/or manufacturer shall certify that materials and end products meet manufacturer's written specifications. Certification shall include manufacturer's part number, specification number, compound number, batch number, mold date and shelf life expiration date.

**6.3.12 METALLIC SEALING MATERIALS QUALITY CONTROL REQUIREMENTS.** Metallic seals shall be in accordance with the manufacturer's written specifications.

**6.3.13 FLEXIBLE CHOKE AND KILL LINES.** This section covers flexible choke and kill lines.

**6.3.13.1 PRESSURE CONTAINING PARTS.** Pressure containing parts of flexible choke and kill lines are:

1. Metallic Wetted-End and Outlet Connections and End Terminations
2. Metallic Non-Wetted-Reinforcement Windings and End Terminations
3. Non-Metallic Non-Wetted pressure containing parts shall be defined by the manufacturer.

**6.3.13.2 QUALITY CONTROL REQUIREMENTS.** Table 6.3.13.3 lists the quality control requirements for the pressure containing parts of flexible lines.

**TABLE 6.3.13.3**  
**QUALITY CONTROL REQUIREMENTS FOR**  
**PRESSURE CONTAINING PARTS OF**  
**FLEXIBLE LINES**

QUALITY REQUIREMENT	METALLIC PARTS (WETTED)	METALLIC PARTS (NON-WETTED)	NON-METALLIC PARTS
Tensile Testing	6.3.6.2	6.3.6.2	N/A
Impact Testing	6.3.6.3	N/A	N/A
Hardness Testing	6.3.6.4	N/A	N/A
Dimensional Verification	6.3.6.5	6.3.6.5	N/A
Traceability	6.3.6.6	6.3.6.6	6.3.13.4
Chemical Analysis	6.3.6.7	6.3.6.7	6.3.13.4.2
Mechanical Testing	N/A	N/A	6.3.13.4
Surface NDE	6.3.6.9	N/A	N/A
Volumetric NDE	6.3.6.10	N/A	N/A
Serialization	6.3.6.13	N/A	N/A
Weld NDE - General	6.3.6.11	N/A	N/A
- Visual Examination	6.3.6.11.1	6.3.6.11.1	N/A
Surface NDE	6.3.6.11.2	N/A	N/A
- Volumetric NDE	6.3.6.11.3	N/A	N/A
- Hardness Testing	6.3.6.11.4	N/A	N/A
- Repair Welds	6.3.6.12	N/A	N/A

**6.3.13.4 NON-METALLIC PARTS MATERIALS.** The following requirements are applicable to thermoplastic and elastomeric materials:

**6.3.13.4.1 Raw Materials.** The manufacturer shall document and retain records for critical materials used in the manufacturing of non-metallic materials.

**6.3.13.4.2 Processed Materials.** The manufacturer shall document and retain records for the processed materials used in pressure containing parts.

**6.3.13.4.3 Testing.** Testing of materials shall be in accordance with applicable ASTM procedures. If a suitable ASTM procedure cannot be applied, the manufacturer shall provide a written procedure.

**6.3.13.4.4 Acceptance Criteria.** Acceptance criteria shall be as identified in the manufacturer's written specification.

**6.3.14 DRILLING CHOKES ACTUATOR CONTROL LINES AND FITTINGS QUALITY CONTROL REQUIREMENTS.** Control lines and fittings for drilling choke actuators shall be in accordance with the manufacturer's written procedures.

#### 6.3.15 RIGID PIPING

**6.3.15.1 CLASSIFICATION.** Pipe is classified as a pressure containing part.

**TABLE 6.3.15.2  
QUALITY CONTROL REQUIREMENTS FOR  
RIGID PIPING**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Hardness Testing	6.3.6.4
Dimensional Verification	6.3.6.5
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7
Visual Examination	N/A
Surface NDE	6.3.6.9
Volumetric NDE	6.3.6.10
Serialization	6.3.6.13

**6.3.16 UNIONS AND SWIVEL UNIONS.** This section applies to unions and swivel unions.

**6.3.16.1 PRESSURE CONTAINING PARTS.** Pressure containing parts of unions and swivel unions are the male and female subs.

**6.3.16.2 QUALITY CONTROL REQUIREMENTS.** The quality control requirements for unions and swivel unions are specified in Table 6.3.16.3.

**TABLE 6.3.16.3  
QUALITY CONTROL REQUIREMENTS FOR  
MALE AND FEMALE SUBS**

QUALITY REQUIREMENT	SECTION
Tensile Testing	6.3.6.2
Impact Testing	6.3.6.3
Hardness Testing	6.3.6.4
Dimensional Verification	6.3.6.5
Traceability	6.3.6.6
Chemical Analysis	6.3.6.7
Visual Examination	N/A
Surface NDE	6.3.6.9
Volumetric NDE	6.3.6.10
Serialization	6.3.6.13
Weld NDE - General	6.3.6.11
- Visual Examination	6.3.6.11.1
- Surface NDE	6.3.6.11.2
- Volumetric NDE	6.3.6.11.3
- Hardness Testing	6.3.6.11.4
- Repair Welds	6.3.6.12

**6.3.17 OTHER PRESSURE BOUNDARY PENETRATIONS.** Other pressure boundary penetrations shall be controlled in accordance with the manufacturer's written specifications.

**6.4 ASSEMBLED EQUIPMENT.** Table 6.4.1 provides a matrix of quality control requirements for assembled equipment.

**TABLE 6.4.1  
QUALITY CONTROL REQUIREMENTS — ASSEMBLED EQUIPMENT**

	Drilling Choke	Actuator	Drilling Choke & Actuator Assembly	Articulated Choke & Kill Lines	Flexible Choke & Kill Lines	Unions & Swivel Unions	Rigid Choke & Kill Lines	Manifold Assembly
Hydrostatic Test	6.4.6	6.4.7	N/A	6.4.9	6.4.10	6.4.11	6.4.12	6.4.13
Function Test	6.4.6.2	6.4.7.2	6.4.8.2	N/A	N/A	N/A	N/A	N/A
Seat to Body Test	6.4.6.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Torque Test	N/A	N/A	6.4.8.1	N/A	N/A	N/A	N/A	N/A
Seal Test	N/A	6.4.7.3	N/A	N/A	N/A	N/A	N/A	N/A
Dimensional Verification	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hydraulic Operating Test	N/A	N/A	6.4.14	N/A	N/A	N/A	N/A	6.4.14

**6.4.2 SERIALIZATION.** Serialization is required on assembled equipment.

**6.4.3 RECORDS.** A record shall be maintained in which serialized parts and individual heat traceable parts (except for replaceable parts, such as orifices and wear trim) are listed as traceable to the assembly. Tests shall be continuously recorded. The pressure test record shall identify the actual test pressure, the pressure holding period, the recording device and shall be dated and signed.

**6.4.4 HYDROSTATIC TESTING.** Assembled equipment shall be subjected to a hydrostatic body test prior to shipment from the manufacturer's facility. Cold (tap) water or water with additives shall be used as the testing fluid. Test pressure shall not be applied as a differential pressure across internal closure mechanisms of chokes. Tests shall be completed prior to painting.

**6.4.4.1 METHOD.** Hydrostatic test for complete assemblies shall consist of three steps:

1. The initial pressure-holding period of not less than three minutes.
2. The reduction of the pressure to zero.
3. The second pressure-holding period of not less than fifteen minutes.

The timing of the test shall not start until the test pressure has been stabilized within the manufacturer's specified range, the equipment and the pressure monitoring gauge have been isolated from the pressure source and the external assembly surfaces have been thoroughly dried.

**6.4.4.2 TEST PRESSURES.** The hydrostatic test pressure shall be determined by the rated working pressure of the equipment. Hydrostatic test pressures shall be as shown in Table 6.4.5.

**6.4.4.3 ACCEPTANCE CRITERIA.** There shall be no visible leakage.

**TABLE 6.4.5**  
**HYDROSTATIC TEST PRESSURES**

<b>RATED WORKING PRESSURE</b> <i>psi</i>	<b>HYDROSTATIC TEST PRESSURE</b> <i>psi</i>
2000	4000
3000	6000
5000	10,000
10,000	15,000
15,000	22,500
20,000	30,000

**6.4.6 DRILLING CHOKES.** Each choke shall be subjected to a hydrostatic test prior to shipment from the manufacturer's facility.

**6.4.6.1 METHOD.** The hydrostatic body test shall be in accordance with Section 6.4.4. In addition, the Function Test in Section 6.4.6.2 shall be performed.

#### **6.4.6.2 FUNCTION TEST**

**6.4.6.2.1 Method.** Cycle the stem at rated working pressure a minimum 20 times, open-close-open.

The mating parts shall be free of all lubrication not specified in the manufacturer's Operating Manual.

**6.4.6.2.2 Acceptance Criteria.** The acceptance criterion shall be continued smooth operation, without binding or chattering.

**6.4.6.3 HYDROSTATIC SEAT TO BODY TEST.** A hydrostatic seat to body test shall be performed by applying rated working pressure and holding for one hour. A blind seat may be used.

#### **6.4.7 ACTUATORS FOR DRILLING CHOKES**

**6.4.7.1 BODY TEST.** Each actuator shall be subjected to a body test in accordance with this Section prior to shipment from the manufacturer's facility.

**6.4.7.1.1 Method.** The test pressure shall be a minimum of 1.5 times the maximum rated working pressure for actuators with a maximum rated working pressure less than or equal to 20,000 psi.

Water (with or without additives), gas, hydraulic fluid or other mixtures of liquids may be used as the testing medium.

**6.4.7.1.2 Acceptance Criteria.** There shall be no visible leakage.

#### **6.4.7.2 FUNCTION TEST**

**6.4.7.2.1 Method.** Each actuator shall be tested for proper operation by cycling the actuator from the normal position to the fully stroked position a minimum of three cycles. The actuator may be tested with the equipment for which it is intended or separately. Test media for hydraulic actuators shall be a suitable hydraulic fluid or a gas such as air or nitrogen.

**6.4.7.2.2 Acceptance Criteria.** The actuator shall operate smoothly in both directions.

#### **6.4.7.3 ACTUATOR SEAL TEST**

**6.4.7.3.1 Method.** Actuator seals shall be pressure tested in two steps by applying pressure of 20% and 100% of the maximum rated working pressure to the actuator. The minimum test duration for each test shall be 10 minutes at 20% and 5 minutes at 100% for pneumatic actuators; 3 minutes at each test pressure for hydraulic actuators.

The test period shall not begin until the test pressure has stabilized and the pressure monitoring device has been isolated from the pressure source. The test pressure reading and time for each holding period shall be recorded.

**6.4.7.3.2 Acceptance Criteria.** The seals shall show no visible leakage under the test of each holding period.

**6.4.8 DRILLING CHOKE AND ACTUATOR ASSEMBLY.** The drilling choke and actuator assembly shall be tested in accordance with this section prior to shipment from the assembler's plant.

**6.4.8.1 OPERATING TORQUE TEST.** The break-away and running torque shall be measured and documented.

**6.4.8.1.1 Method.** The measurement method shall be documented by the manufacturer's written specification.

**6.4.8.1.2 Acceptance Criteria.** The operating force or torque shall be within the manufacturer's specification.

#### **6.4.8.2 FUNCTION TEST**

**6.4.8.2.1 Method.** Each choke and actuator assembly shall be tested for proper operation by cycling the actuator from the normal position to the fully stroked position a minimum of three cycles.

**6.4.8.2.2 Acceptance Criteria.** The actuator shall operate smoothly in both directions.

**6.4.9 ARTICULATED CHOKE & KILL LINES.** Articulated Choke and Kill Line assemblies shall be hydrostatically tested prior to leaving the manufacturer's facility.

**6.4.9.1 METHOD.** Each assembly shall be pressurized to the test pressure as specified in Table 6.4.5.

1. The test pressure shall be held for a minimum of one hour.

2. The test shall be conducted at room temperature.

3. The temperature and pressure shall be recorded during the test, as the day/night temperature variations may account for some slight pressure variations.

**6.4.9.2 ACCEPTANCE CRITERIA.** There shall be no visible leakage.

**6.4.10 FLEXIBLE CHOKE & KILL LINES.** Each flexible line assembly shall be subjected to a hydrostatic pressure test.

**6.4.10.1 METHOD.** Flexible line assemblies shall be pressurized to the test pressure as specified in Table 6.4.5.

1. The test pressure shall be held for a minimum of one hour.

2. The test shall be conducted at room temperature.

3. The temperature and pressure shall be recorded during the test, as the day/night temperature variations may account for some slight pressure variations.

**6.4.10.2 ACCEPTANCE CRITERIA.** There shall be no visible leakage during the test.

**6.4.11 UNIONS AND SWIVEL UNIONS.** Each union and swivel union shall be subjected to a hydrostatic test prior to leaving the manufacturer's facility.

The hydrostatic test shall be in accordance with Section 6.4.4.

**6.4.12 RIGID CHOKE AND KILL LINE.** The rigid choke and kill line shall be subjected to a hydrostatic test prior to shipment from the manufacturer's facility.

**6.4.12.1 METHOD.** Flexible line assemblies shall be pressurized to the test pressure as specified in Table 6.4.5.

1. The test pressure shall be held for a minimum of one hour.

2. The test shall be conducted at room temperature.

3. The temperature and pressure shall be recorded during the test, as the day/night temperature variations may account for some slight pressure variations.

**6.4.12.2 ACCEPTANCE CRITERIA.** There shall be no visible leakage.

**6.4.13 ASSEMBLED MANIFOLD.** The manifold assembly shall be subjected to a hydrostatic test as per Table 6.4.5 prior to shipment from the assembler's facility. Manifold assemblies with parts having different working pressures, the lowest rated working pressure shall be used to determine the test pressure.

A traceability record shall be prepared in which serialized equipment is traceable to the manifold assembly (e.g., assembly part number, serial number).

**6.4.14 HYDRAULIC CONTROL SYSTEM.** The operating system test shall be conducted on the actuating system of remotely controlled equipment.

**6.4.14.1 METHOD.** The operating system test shall be in accordance with Section 6.4.4 except that the test pressure shall be a 1.5 times the system rated working pressure minimum. The test media shall be a suitable hydraulic fluid or a gas such as air or nitrogen.

**6.4.14.2 ACCEPTANCE CRITERIA.** There shall be no visible leakage.

**6.5 QUALITY CONTROL RECORD REQUIREMENTS.** The quality control records required by this Specification are those documents and records necessary to substantiate that materials and products made to this specification conform to the specified requirements.

**6.5.1 NACE RECORD REQUIREMENTS.** Records required to substantiate conformance of equipment to NACE requirements shall be in addition to those described in other sections of this document unless the records required by this specification also satisfy the NACE Standard MR0175 requirements.

**6.5.2 RECORDS CONTROL.** Records required by this Specification shall be legible, identifiable, retrievable and protected from damage, deterioration, or loss. Records shall be signed and dated. Computer stored records shall contain originator's personal code. Records shall be maintained for five years following the date of manufacture.

**6.5.3 RECORDS TO BE MAINTAINED BY THE MANUFACTURER**

1. Weld Procedure Qualification Record
2. Welder Qualification Record
3. Material Test Records:
  - Chemical Analysis
  - Tensile Tests (QTC)
  - Impact Tests (QTC, as required)
  - Hardness Tests (QTC)
4. NDE Personnel Qualification Records
5. NDE Records:
  - Surface NDE Records
  - Full Penetration Fabrication
  - Weld Volumetric NDE Records
  - Repair Weld NDE Records

- 6. Hardness Test Records
- 7. Welding Process Records
  - Welder Identification
  - Weld Procedures
  - Filler Materials
  - Post-Weld Heat Treatments
- 8. Heat Treatment Records
  - Actual Temperature
  - Actual Times at Temperature
- 9. Volumetric NDE Records
- 10. Hydrostatic Pressure Test Records
- 11. Critical Dimensions

**6.5.4 RECORDS TO BE FURNISHED TO PURCHASERS.** The assembled equipment records listed in this Section shall be provided by the manufacturer to the original purchaser of API Spec 16C equipment. These records, where applicable, shall be identical to or contain the same information as those retained by the manufacturer. Each record shall prominently reference part serial number.

1. Certificate of compliance stating that equipment conforms to current edition of API Spec 16C and the temperature class.

2. Assembly Traceability Records

3. Pressure Test Records

## SECTION 7 MARKING

Equipment manufactured in accordance with this specification shall be marked in accordance with the procedures and requirements of this section. The API Specification 16C identity shall be applied only as specified and only by manufacturers who meet all the requirements of this specification. Equipment manufactured in accordance with API Specification 6A or API Specification 16A shall be marked in accordance with the procedures and requirements of that specification.

**7.1 LOW STRESS AREA MARKING.** For identification on low stress areas (such as nameplates, outside diameters of flanges, etc.), the use of sharp "V" stamping is acceptable.

**7.2 HIGH STRESS AREA MARKING.** For identification on high stress areas, dot, vibration or round "V" stamping is acceptable. Sharp "V" stamping is allowed in high stress areas only if subsequent stress relieving is performed to the component.

### 7.3 EQUIPMENT SPECIFIC MARKING

**TABLE 7.3.1  
METALLIC MARKING REQUIREMENTS**

	articulated lines swivel joints unions rigid piping	flexible C & K lines	drilling choke	drilling choke actuators	C & K manifold assembly
Spec 16C	OD	termination OD	Nameplate <sup>1</sup>	Nameplate	Nameplate
assembly serial number	NA	NA	Body and Nameplate	Nameplate	NA
connector size	OD	connector OD	connector OD	NA	NA
date of manufacture (month & year)	OD	termination OD	Body or Nameplate	Body or Nameplate	Nameplate
flow direction	NA	NA	Body	NA	NA
mfg. name or mark	OD	termination OD	Nameplate	Nameplate	Nameplate
rated working pressure	OD	termination OD	Nameplate & termination OD	NA	Nameplate
ring gasket type & number	OD	connector OD	connector OD	NA	NA
schedule/grade	OD	NA	NA	NA	NA
safety clamp	NA	termination OD <sup>2</sup>	NA	NA	NA
size	OD	termination OD	Nameplate	Nameplate	NA
thread size	NA	NA	Adjacent to Thread	NA	NA
temperature rating	OD	termination OD	Nameplate and Body	Nameplate and Body	Nameplate
test pressure	OD	termination OD	NA	NA	Nameplate
orifice area	NA	NA	Body & Nameplate	NA	NA

<sup>1</sup> Nameplate marking requirements are satisfied by body marking.

<sup>2</sup> Safety clamp location notation shall be within three feet of the end termination.

**7.4 HARDNESS MARKING FOR BODIES, BONNETS, AND FLANGES.** When hardness tests are required, the actual value of the hardness test shall be stamped on the part adjacent to the test location.

## SECTION 8 STORING AND SHIPPING

### 8.1 STORING

**8.1.1 DRAINING AFTER TESTING.** Equipment shall be drained after testing and prior to storage.

**8.1.2 RUST PREVENTION.** Prior to storage, parts and equipment shall have exposed metallic surfaces protected with a rust preventative which does not become fluid at below 125°F.

**8.1.3 SEALING SURFACE PROTECTION.** Flanges, hub faces, sealing surfaces and ring gasket grooves shall be protected.

**8.1.4 PORTS.** Ports shall be plugged.

**8.1.5 HYDRAULIC OPERATING SYSTEM.** The hydraulic operating system shall be flushed with a cor-

rosion inhibiting antifreeze in accordance with the manufacturer's written procedures. Ports shall be plugged prior to storing.

**8.1.6 NON-METALLIC MATERIALS.** Age control procedures and protection of non-metallic materials shall be in accordance with the manufacturer's written specification. The manufacturer shall document the age and storage dates.

**8.1.7 RING GASKETS.** Loose ring gaskets shall be individually wrapped and/or boxed for storing and shipping.

**8.2 SHIPPING.** Equipment is to be shipped in accordance with the manufacturer's written procedures.

## SECTION 9

### EQUIPMENT SPECIFIC REQUIREMENTS

This section sets forth specific equipment requirements, performance requirements and performance verification requirements. Performance requirements apply to all products being manufactured and delivered for service. Performance verification procedures are imposed on new products and product design changes. Verification testing shall be performed on prototypes or production models.

**9.1 PERFORMANCE VERIFICATION.** Performance verification procedures shall be applied to designs and design changes of products and assemblies. Verification testing shall be performed on prototypes or production models to verify that the performance requirements specified for pressure, temperature, load mechanical cycles and standard test fluids are met in the product design.

**9.1.1 SCALING.** Scaling of size and pressure ratings may be used to verify the members of a product family in accordance with the requirements and limitations of this section.

**9.1.1.1 PRODUCT FAMILY.** A product family shall meet the following design requirements.

**9.1.1.1.1 Configuration.** The design principles of physical configuration and functional operation are the same.

**9.1.1.1.2 Design Stress Levels.** The design stress levels in relation to material mechanical properties are based on the same criteria.

**9.1.1.2 LIMITATIONS OF SCALING.** Verification by scaling is subject to the following limitations.

**9.1.1.2.1 Verification by Pressure Rating.** The test product may be used to qualify products of the same family having equal or less pressure rating.

**9.1.1.2.2 Verification by Size.** Testing of one size of a product family shall verify products one nominal size larger and one nominal size smaller than the tested size, with the exception of Flexible Choke & Kill Lines. Testing of two sizes also verifies nominal sizes between the two sizes tested.

**9.1.1.2.3 Determination of Choke Nominal Size.** The choke nominal size shall be defined as the size of the maximum orifice which may be used in that choke (orifice sizes smaller than the nominal size do not require testing). Choke nominal sizes are in one-inch increments.

**9.1.1.2.4 Determination of Other End Connector Nominal Sizes.** The nominal size of other end connectors shall be defined as the nominal end connector size and lowest rated working pressure. Use tables from Section 3.4.

**9.1.1.3 VERIFICATION BY TEMPERATURE RATING.** The temperature range verified by the test product shall verify temperature classifications that fall entirely within that range.

**9.1.1.4 VERIFICATION BY STANDARD TEST FLUID RATING.** Test products verified by the standard test fluid performance verification shall verify the

same product family and material properties as the test product.

**9.1.2 DESIGN CHANGES.** A design that undergoes a substantive change becomes a new design requiring performance verification. A substantive change is a change identified by the manufacturer which affects the performance of the product in the intended service condition. This may include changes in fit, form, function or material.

**9.1.3 METALLIC MATERIALS.** A change in metallic materials may not require new performance verification if the suitability of the new material can be substantiated by other means. The standard test fluid compatibility shall be documented by testing or reference to established documentation confirming compatibility.

**9.1.4 NONMETALLIC SEALS.** A change in nonmetallic materials may not require new performance verification if the suitability of the new material can be substantiated by other means. Substantive changes of the original documented design configuration of nonmetallic seals resulting in a new design will require performance verification in accordance with Sections 9.1 and 9.4.

**9.2 ACCEPTANCE CRITERIA.** Verification testing of the product shall include all of the testing requirements of this section.

**9.2.1 STRUCTURAL INTEGRITY.** The product tested shall not permanently deform to the extent that any other performance requirement is not met.

#### 9.2.2 PRESSURE INTEGRITY

**Hydrostatic Test At Room Temperature —** The hydrostatic test at room temperature shall be acceptable if no visible leakage occurs during the specified pressure hold periods of the test. The pressure change observed on the pressure measuring device during the hold period shall be less than 5% of the test pressure or 500 psi, whichever is less.

**Minimum/Maximum Temperature Tests —** The hydrostatic at high or low temperatures shall be acceptable if the pressure change observed on the pressure measuring device is less than 5% of the testing pressure or 500 psi, whichever is less.

#### 9.2.3 STANDARD TEST FLUID COMPATIBILITY.

**Metallic Materials —** The standard test fluid compatibility of metallic materials shall be documented by testing or reference to established documentation confirming compatibility.

**Nonmetallic Seals —** The acceptance criteria for the standard test fluid compatibility of nonmetallic seals shall be as specified in Table 9.4.4.

**9.2.4 POST TEST EXAMINATION.** The tested prototype must be disassembled and inspected. All relevant items should be photographed. The examination shall



include a written statement that the product and component design does not contain defects to the extent that any performance requirement is not met.

### 9.3 HYDROSTATIC TESTING

**9.3.1 TESTING MEDIUM.** The testing medium shall be a fluid suitable for the testing temperatures. Water with or without additives, gas, hydraulic fluid, or other mixtures of fluids may be used as the testing medium. The testing medium shall be a fluid that remains in the liquid or gaseous state throughout the test.

**9.3.2 SUBSTITUTION OF GAS.** The manufacturer may, at his option, substitute gas for liquid where hydrostatic testing is specified, provided the testing method and acceptance criteria for gas testing are used. If gas is substituted for liquid the following criteria shall be followed:

#### Gas Testing

**Testing Medium** — Air, nitrogen, methane or other gases or mixtures of gases may be used.

**Leak Detection** — Gas testing at room temperature shall be conducted with a method for leak detection. The product may be completely submerged in a liquid, or the product may be flooded in the seal areas being verified so all possible leak paths are covered. The product may be assembled with one end of a tube connected to a blind connector enclosing possible leak paths being verified. The other end of the tube shall be immersed in a liquid or attached to a leakage measurement device.

### 9.3.3 TEMPERATURE TESTING

**9.3.3.1 LOCATION OF TEMPERATURE MEASUREMENT.** Temperature shall be measured in contact with the equipment being tested within 1/2 inch of the through-bore where applicable and within 1/2 inch of the surface wetted by the retained fluid on the other equipment.

**9.3.3.2 APPLICATION OF HEATING FOR MAXIMUM TEMPERATURE TESTING.** The heating for maximum temperature tests may be applied internally in the through-bore or externally. The heating shall be applied such that the entire through-bore or equivalent wetted surface is at or above the maximum temperature.

**9.3.3.3 APPLICATION OF COOLING FOR MINIMUM TEMPERATURE TESTING.** The cooling for minimum temperature tests shall be applied to the entire external surface of equipment.

### 9.3.4 HOLD PERIODS

**9.3.4.1 START OF HOLD PERIODS.** Hold periods shall start after pressure and temperature stabilization has occurred and the equipment with pressure monitoring device has been isolated from the pressure source. The time specified for hold times shall be a minimum.

**9.3.4.2 PRESSURE STABILIZATION.** Pressure shall be considered stabilized when the change rate is no more than 5% of the testing pressure per hour or 500 psi/hour, whichever is less. Pressure shall remain within 5% of the testing pressure or 500 psi, whichever is less, during the hold period.

**9.3.4.3 TEMPERATURE STABILIZATION.** Temperature shall be considered stabilized when the rate of change is less than 1°F per minute. The temperature shall remain at or beyond the extreme during the hold period, but shall not exceed the extreme by more than 20°F.

### 9.3.4.4 PRESSURE AND TEMPERATURE CYCLES

**Pressure/Temperature Cycles** — Pressure/temperature cycles shall be performed as specified in Section 9.

**Testing Pressure And Temperature** — The testing pressure and temperature extremes shall be as specified in Section 3.

### 9.4 NON-METALLIC SEALS

**9.4.1 DESIGN.** Design of non-metallic seals shall be in accordance with the requirements of Section 3 and the manufacturer's written specification.

**9.4.2 MATERIALS.** Materials for non-metallic seals shall be in accordance with the requirements of Section 4.1.2.

**9.4.3 QUALITY.** Non-metallic seals shall meet the quality requirements as per Section 6.3.11.

**TABLE 9.4.4  
STANDARD TEST FLUID**

Fluid	% by Volume	Remarks
Oil	50	Diesel #2 (ASTM D 975)
Brine Water	20	Saturated salt at 60°F (15,5°C)
Gas	30	
Methane (CH <sub>4</sub> )		
85%		
Carbon Dioxide (CO <sub>2</sub> )		
5%		
Hydrogen Sulfide (H <sub>2</sub> S)		
10%		

**9.4.5 PERFORMANCE VERIFICATION.** Nonmetallic seals exposed to well fluids, produced or injected, shall undergo the performance verification procedures of this section.

**9.4.5.1 INTENT OF PROCEDURE.** This procedure is intended to verify seal performance for the standard test fluid as specified in Table 9.4.4, not the performance of products containing the seal. Seals shall be tested as specified in this Section to determine temperature and pressure performance.

**9.4.5.2 THERMOCHEMICAL PERFORMANCE OF SEAL MATERIALS.** The fluid compatibility of the seal materials shall be verified by a test demonstrating the response of the seal exposure to the

standard test fluid, at or above the maximum rated temperature, Section 3.5.2.

#### 9.4.5.2.1 TEMPERATURE TESTING

**9.4.5.2.1.1 LOCATION OF TEMPERATURE MEASUREMENT.** Temperature shall be measured in contact with the equipment being tested within 1/2 inch of the through-bore where applicable and within 1/2 inch of the surface wetted by the retained fluid on other equipment.

**9.4.5.2.1.2 APPLICATION OF HEATING FOR MAXIMUM TEMPERATURE TESTING.** The heating for maximum temperature tests may be applied internally in the through-bore or externally. The heating shall be applied such that the entire through-bore wetted surface is at or above the maximum temperature.

**9.4.5.2.1.3 APPLICATION OF COOLING FOR MINIMUM TEMPERATURE TESTING.** The cooling for minimum temperature tests shall be applied to the entire external surface of the equipment.

**9.4.5.2.2 TEST TEMPERATURE.** The test temperature shall be the specified temperature for the temperature rating being tested, see Section 3.5.2.

**9.4.5.2.3 TEST PRESSURE.** The rated working pressure test, at the test temperature, shall be as per Section 3.4. The low pressure test shall be at 200 psi (1,4 MPa).

**9.4.5.2.4 TEST CYCLE.** The test cycle shall have five pressure hold periods as per the listed test steps.

1. At room temperature, apply rated working pressure. After pressure has stabilized, hold for 1 hour.
2. Release test pressure.
3. Raise temperature to at least the maximum temperature rating.
4. Raise pressure to rated working pressure. After stabilizing pressure, hold for 12 hours.
5. Release pressure.
6. Raise pressure to rated working pressure. After stabilizing pressure, hold for 12 hours.
7. Release pressure and heating.
8. Lower temperature to minimum temperature rating.
9. Raise pressure to rated working pressure. After stabilizing pressure, hold for 1 hour.
10. Release pressure and cooling.
11. After stabilization at room temperature, raise pressure to 200 psi (1,4 MPa). After pressure stabilization, hold for 1 hour.
12. Raise pressure to rated working pressure. After stabilization, hold for 1 hour.

**9.4.5.2.5 TESTING.** A seal may be tested in fixtures or products that represent the specified nominal clearances and extrusion gaps specified for the manufactured part.

**9.4.5.2.6 TEST FLUID APPLICATION.** The standard test fluid is delineated in Table 9.4.4. The product or fixture shall be positioned so that the seal is partially exposed to both the liquid and the gas phases. The hydrocarbon liquid shall be over pressured with the gas mixture.

**9.4.5.2.6.1 ACCEPTANCE CRITERIA.** There shall be no visible leakage during pressure hold periods. The pressure tests are acceptable if the pressure change is less than 5% of the testing pressure or 500 psi (4,9 MPa), whichever is less.

**9.4.5.2.6.2 IMMERSION TESTING.** The acceptance criteria for the standard test fluid compatibility of nonmetallic seals exposed to immersion testing shall be documented by and as per the manufacturer's written specification. The manufacturer's written specification shall include as a minimum the requirements from Section 4.1.2, test procedure, compound identity and acceptance criteria.

**9.4.5.2.6.3 FIXTURE TESTING.** A seal that passes Section is acceptable without running Fixture Testing. A seal that passes the Fixture Testing is acceptable even if it fails the Immersion Testing. A material that fails the Fixture Testing is not acceptable.

**9.5 END AND OUTLET CONNECTIONS.** The three types of end and outlet connections, 6B and 6BX as defined in API Specification 6A, Section 900 and 16BX as defined in API Specification 16A, Section III, may be used as connections for equipment covered by this specification. Type 6B may also be used as a threaded flange.

**9.5.1 RATED WORKING PRESSURE AND SIZES FOR CONNECTIONS.** Type 6B, 6BX and 16BX connections are designed for use in the combination of sizes and ranges and pressure ratings as referenced in Table 9.5.2.

**TABLE 9.5.2  
RATED WORKING PRESSURES & SIZES FOR  
END & OUTLET CONNECTIONS**

Rated Working Pressure psi (MPa)	Type 6B in. (mm)	Type 6BX in. (mm)	Type 16BX in. (mm)
2000 (13,8)	2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)		
3000 (20,7)	2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)		
5000 (34,5)	2 1/16 (52) 2 9/16 (65) 3 1/8 (78) 4 1/16 (103)		2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)
10,000 (69,0)		1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)
15,000 (103,5)		1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)
20,000 (138,0)		1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)	1 13/16 (46) 2 1/16 (52) 2 9/16 (65) 3 1/16 (78) 4 1/16 (103)

**9.5.3 6B FLANGE CONNECTIONS.** Type 6B flange connections are of the ring joint type. These flange connections are not designed for face-to-face make-up. The connection make-up bolting force reacts on the metallic ring gasket. The Type 6B flange may be of the through bolted or studded design. Type 6B flange connections shall use Type R or Type RX gaskets. Dimensions for Type 6B flanges shall conform to API Specification 6A, Section 900.

**9.5.4 6BX FLANGE CONNECTIONS.** 6BX flange connections are of the ring joint type. These connections are designed for face-to-face make-up. Dimensions for Type 6BX flange connections shall conform to API Specification 6A, Section 900.

**9.5.5 16BX HUBBED CONNECTIONS.** Type 16BX end and outlet hubs are controlled by API Specification 16A, Section III. API Type 16BX hubs are designed for use in the combination of nominal size ranges and pressure ratings as referenced in Table 9.5.2. Type 16BX hubs are of the ring joint type and are designed for face-to-face make-up.

Clamps will be addressed in future specification editions.

**9.5.6 OTHER END CONNECTORS.** Refer to API Specification 6A, Section 918, for other end connectors, which may be used for joining pressure containing equipment.

**9.5.7 CORROSION RESISTANT RING GROOVES.** Type 6B flange connections may be manufactured with corrosion resistant overlays in the ring grooves in accordance with API Specification 6A.

**9.6 UNIONS & SWIVEL JOINTS.** Unions consist of a male sub with a special contact face by means of a nut which threads onto the female sub and retains the male against a shoulder.

**9.6.1 DESIGN.** Design of Unions and Swivel Joints shall be in accordance with Section 3.

**9.6.2 MATERIALS.** Materials for Unions and Swivel Joints shall be in accordance with Section 4.

**9.6.3 QUALITY.** Unions and Swivel Joints shall be in accordance with Section 6.3.

**9.6.4 END CONNECTION.** Unions are to be supplied with Butt Weld Ends. Line pipe threads are not an acceptable end connection.

**TABLE 9.6.5  
UNION & SWIVEL JOINT RATED WORKING PRESSURES & SIZES**

Unions and swivel joints shall be supplied in these rated working pressures and sizes.

Rated Working Pressure <i>psi (MPa)</i>	Test Pressure <i>psi (MPa)</i>	Nominal Size <i>inches (mm)</i>
3000 (20,7)	6000 (41,4)	2 (51) 3 (76) 4 (102)
5000 (34,5)	10,000 (69,0)	1 (25) 1 ½ (38) 2 (51) 3 (76) 4 (102)
10,000 (69,0)	15,000 (103,5)	1 (25) 2 (51) 3 (76) 4 (102)
15,000 (103,5)	22,500 (15,0)	2 (51) 2 ½ (64) 3 (76)
20,000 (138,0)	30,000 (207,0)	2 (51) 2 ½ (64) 3 (76)

**9.7 RING GASKETS.** Gaskets used for equipment manufactured to this specification shall meet the requirements of API Specification 6A or 16A.

Type R, RX and BX ring-joint gaskets are used in flanged, studded and hubbed connections. Types R and RX gaskets are interchangeable in Type R ring grooves. Only Type BX gaskets are to be used with 6BX ring grooves. Type RX and BX gaskets are not interchangeable.

**REUSE OF GASKETS:** Ring gaskets have a limited amount of positive interference, which assures that the gasket will be joined into a sealing relationship in the flange grooves. **These gaskets shall not be reused.**

**9.8 STUDS AND NUTS.** The requirements for studs and nuts apply only to those used to connect end and outlet flanges. The requirements for studs and nuts are found in API Specification 6A or 16A.

**9.9 DRILLING CHOKES.** This section covers drilling chokes used to control back pressure in a well control situation. Drilling chokes are not intended to be used as shut off valves.

**9.9.1 DESIGN.** Design of Drilling Chokes shall be in accordance with Section 3 and this Section.

**9.9.2 ADJUSTABLE DRILLING CHOKES.** Adjustable drilling chokes have an externally controlled variable area orifice such as a rotary disc, gate and seat, or needle. Adjustable drilling chokes may be controlled manually or remotely. Adjustable drilling chokes shall be equipped with a visible orifice area indicating mechanism, showing percent open or closed.

**9.9.3 POSITIVE DRILLING CHOKES.** Positive drilling chokes accommodate replaceable parts having fixed orifice dimensions, which are commonly called flow beans.

**9.9.4 VENT REQUIREMENT.** Adjustable drilling chokes shall be designed to vent trapped pressure prior to releasing the body-to-bonnet connection. Positive Drilling chokes shall be designed to vent trapped pressure before releasing the body-to-cap connection is disengaged.

**9.9.5 SIZE DESIGNATION.** The nominal size designation of the drilling choke shall be the inlet connection size, in inches, followed by the maximum orifice area, in square inches.

**9.9.6 MINIMUM ORIFICE SIZE.** Drilling chokes shall be designed to pass a 1/2 inch (12,7 mm) diameter particle, when fully open.

**9.9.7 FLOW DESIGN.** Drilling chokes shall be designed to direct flow away from the bonnet of adjustable chokes and the cap or blanking plug, of positive chokes. Adjustable chokes shall be designed to limit unintentional position movement during use.

**9.9.8 END CONNECTIONS.** The inlet and outlet connections shall be the same size.

**9.9.9 RATED WORKING PRESSURE.** Drilling chokes having end connections of the same rated working pressure, shall have the rated working pressure of the end connections. For drilling chokes having an inlet connection of higher rated working pressure than the

outlet connection, the drilling choke shall have a two-part rated working pressure consisting of the inlet rated working pressure and the outlet rated working pressure (e.g. 15,000 psi (103,5 MPa) x 10,000 psi (69,0 MPa)).

**9.9.10 PERFORMANCE REQUIREMENTS.** Drilling chokes shall meet the general performance requirements of Section 3, Section 9 and Table 9.9.11. These requirements include positive chokes, adjustable chokes and chokes designed for actuators.

**TABLE 9.9.11  
PERFORMANCE REQUIREMENTS  
FOR DRILLING CHOKES**

operating cycles <sup>6</sup>	200
seat to body sealing cycles	3

#### **9.9.12 MATERIALS**

**9.9.12.1 METALLIC MATERIALS.** Materials for bodies, bonnets, plugs, caps, end connections and parts shall be in accordance with Section 4.

**9.9.12.2 NON-METALLIC SEALS.** Non-metallic seals shall be in accordance with Section 4.

#### **9.10 PERFORMANCE VERIFICATION FOR DRILLING CHOKES**

**9.10.1 DYNAMIC TEST AT ROOM TEMPERATURE.** A dynamic test at room temperature shall be performed in accordance with Section 9.10.1.1.

**9.10.1.1 METHOD.** Apply and maintain rated working pressure at room temperature. Cycle the stem a minimum of 160 times fully open to fully closed and back to fully open. Mating parts shall be free of lubrication not specified in the manufacturing assembly procedures or maintenance procedures. Stem cycle operation shall be smooth and without binding or chattering during operational cycles in accordance with the manufacturer's written specification.

**9.10.2 DYNAMIC TEST AT MAXIMUM RATED TEMPERATURE.** A dynamic test at maximum rated temperature shall be performed in accordance with Section 9.10.2.

Apply and maintain rated working pressure and maximum rated temperature. Cycle the stem a minimum of 20 times fully open to fully closed and back to fully open. The test fluid shall be water or water with additives. Mating parts shall be free of lubrication not specified in the manufacturing assembly procedures or maintenance procedures. Stem cycle operation shall be smooth and without binding or chattering during operational cycles in accordance with the manufacturer's written specification.

**9.10.3 DRILLING CHOKES AND ACTUATOR ASSEMBLY FUNCTION TESTING.** The drilling choke and actuator assembly shall be tested in accordance with this section prior to shipment. Water or water with additives shall be used as the test fluid. Any additives shall be documented in the test records.

**9.10.3.1 TEST CIRCUIT.** The drilling choke with the actuator assembled shall be installed in a fluid

<sup>6</sup>Operating cycles do not apply to positive chokes.

flow circuit or manifold having a rated working pressure equal to or greater than, the rated working pressure of the choke.

**9.10.3.2 FLOW CAPACITY.** The fluid flow circuit or manifold testing apparatus shall be capable of flowing test fluid through the choke bore up to the rated working pressure of the choke at a minimum rate of 5 gallons per minute for the test duration.

**9.10.3.3 TEST POSITION.** The choke/actuator shall be positioned within the fluid flow circuit or manifold such that the entire testing apparatus and the choke cavity upstream of the choke seal elements are full of test fluid prior to initiating the test, and will remain full with no trapped air during the test cycles.

**9.10.3.4 DATA RECORDING.** A pressure recording device shall be installed upstream of the choke and the pressure continuously recorded during the function test.

**9.10.3.5 CONTROL CONSOLE.** The actuator shall be operated by a choke control console. A control system which is representative of the form and functions of a choke control console is acceptable.

**9.10.3.6 TEST SEQUENCE.** The function test shall consist of 3 cycles in the following sequence:

1. Using the choke control system, fully open the choke and flow test fluid through the choke at a minimum rate of 5 gallons per minute.

2. Using the choke control system in a normal operating procedure, close the choke. The choke shall be completely closed in 30 seconds or less.

3. As the choke closes, choke pressure shall rise until the rated working pressure is reached. If the choke does not provide complete shut-off capability, it shall attain the maximum operating pressure contained in the choke manufacturer's written specification.

4. Rated working pressure shall be established on the upstream side of the choke before the console control device is manipulated in a normal manner to the choke open position.

5. The choke shall operate from fully closed to fully open in 30 seconds or less.

6. The pressure recording device shall document the pressure increase as the choke closes and the pressure decrease as the choke opens.

**9.11 ACTUATORS FOR DRILLING CHOKES.** This section covers hydraulically powered actuators for drilling chokes contained within a choke and kill system. This includes single and double acting linear and limited turn rotary actuators. Electrically powered or electric motor driven actuators are beyond the scope of this specification.

**9.11.1 PERFORMANCE REQUIREMENTS.** Actuators must meet the performance requirements of this section. The maximum required operating temperature for hydraulic actuators is 150°F (65.5°C). Actuators shall be capable of performing as outlined in Table 9.11.2.

**TABLE 9.11.2  
PERFORMANCE REQUIREMENTS FOR  
DRILLING CHOKES ACTUATORS**

operating cycles	200
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**9.11.3 DESIGN CRITERIA.** Actuators shall have a pressure working rating as specified by the manufacturer's written specification.

**9.11.3.1 CONNECTIONS.** Fluids connections shall be in accordance with Section 9.16.13. Hydraulically powered actuators may have connections smaller than 1/2 inch (12.7 mm).

**9.11.3.2 ACTUATION FORCES.** Actuator output forces must meet or exceed the operating requirements specified by the choke manufacturer.

**9.11.3.3 PRESSURE RELIEF.** Actuators must be designed to prevent pressure buildup within the actuator housing or cylinder due to leakage from the choke.

#### **9.11.4 MATERIAL**

**9.11.4.1 WRITTEN SPECIFICATION.** Metallic and non-metallic materials used in actuators shall meet the requirements of Section 4 and shall have written material specifications. The manufacturer's written specification shall define (as a minimum):

Mechanical Properties

Chemical Composition (metallic materials)

Heat Treat Procedures (metallic materials)

Compound Identification (non-metallic materials)

Acceptance criteria

**9.11.4.2 NON-METALLIC SEALING ELEMENTS.** Non-metallic seal materials exposed to well fluids shall meet Section 9.1. Non-metallic seal materials not exposed to well fluids shall meet the manufacturer's written specification.

**9.11.5 QUALITY.** Actuators shall be in accordance with Section 6.3.10 and the specific requirements of Section 9.9.

**9.11.6 MARKING.** Actuators shall be marked in accordance with Table 7.3.1.

**9.11.7 STORAGE AND SHIPPING.** Actuators shall be stored and shipped in accordance with Section 8 and the following additional criteria:

1. Actuators shall be drained and lubricated after testing and prior to storage or shipment.

2. Prior to shipment, parts and equipment shall have exposed metallic surfaces protected with a rust preventive which will not become fluid at a temperature less than 125°F (51.67°C). Inherently, corrosion resistant materials do not require protection.

3. Exposed sealing surfaces shall be protected from damage during storage or shipment.

#### **9.12 PERFORMANCE VERIFICATION FOR DRILLING CHOKES ACTUATORS**

**9.12.1 PERFORMANCE VERIFICATION TESTING PROCEDURE.** Testing media for hydraulic actuators shall be a suitable hydraulic fluid.

**9.12.2 ACTUATOR SEAL TEST AT ROOM TEMPERATURE.** The actuator seals shall be pressure tested in two steps by applying pressure of 20% and 100% of the maximum rated working pressure to the actuator. The minimum test duration for each test shall be three minutes at 20% and 100% for hydraulic actuators.

The test period shall not begin until the test pressure has stabilized. The test results shall be recorded. The seals shall show no visible leakage under the test of each holding period.

**9.12.3 OPERATIONAL TEST AT ROOM TEMPERATURE.** The actuator shall be tested for proper operation by cycling the actuator from the normal position to the fully stroked position a minimum of 160 cycles. The actuator shall operate smoothly in both directions. The pressure applied shall be equal to the rated working pressure of the actuator.

**9.12.4 OPERATIONAL TEST AT MAXIMUM RATED TEMPERATURE.** The actuator shall be tested for proper operation by cycling the actuator at maximum rated temperature from the normal position to the fully stroked position a minimum of 20 cycles. The actuator shall operate smoothly in both directions. The pressure applied shall be equal to the rated working pressure of the actuator.

**9.12.5 OPERATIONAL TEST AT MINIMUM RATED TEMPERATURE.** The actuator shall be tested for proper operation by cycling the actuator at minimum rated temperature from the normal position to the fully stroked position a minimum of 20 cycles. The actuator shall operate smoothly in both directions. The pressure applied shall be equal to the rated working pressure of the actuator.

**9.12.6 PRESSURE-TEMPERATURE CYCLES.** The pressure-temperature cycles shall be as follows:

1. Raise temperature to room temperature.
2. Apply testing pressure at room temperature and maintain while raising temperature to maximum rated temperature.
3. Hold pressure and temperature for one hour minimum.
4. Reduce to minimum rated temperature while maintaining test pressure.
5. Hold pressure and temperature for one hour minimum.
6. Raise to room temperature while maintaining test pressure.
7. Release pressure and raise temperature to maximum rated value.

8. Apply testing pressure and hold for one hour minimum.

9. Release pressure and reduce temperature to minimum rated temperature.

10. Apply test pressure and hold for one hour minimum.

11. Release pressure and raise to room temperature.

12. Apply testing pressure and hold for one hour minimum.

13. Release pressure.

### 9.13 RIGID PIPING

**9.13.1 DESIGN.** The design thickness for a rated working pressure of 10,000 psi (69.0 MPa) or less, shall be in accordance with ANSI B 31.3 part 2 or ASME pressure vessel code, Section VIII, Division 2. For rated working pressures above 10,000 psi (69.0 MPa), ASME 31.3 Chapter 9, ASME pressure vessel code, Section VIII, Division 2 shall be used. For all pressure ratings the design allowable stresses shall be in accordance with Section 3.

**9.13.2 MATERIALS.** Materials for rigid piping shall be in accordance with Section 4.6.

**9.13.3 QUALITY.** Quality requirements for rigid piping shall be in accordance with 6.3.15.

**9.14 FLEXIBLE CHOKE AND KILL LINES.** Choke and Kill Lines are an integral part of the surface blowout prevention equipment required for drilling well control. The kill line provides a means of pumping fluid into the well bore when normal circulation through the drill string cannot be employed. The choke line and manifold provide a means of applying back pressure on the formation while circulating out formation fluid influx into the well bore following a "kick".

Flexible Choke and Kill Lines are employed when it is necessary to accommodate either relative motion such as that encountered on a jack-up, semisubmersible or barge rig, dimensional variation on sequential rig-ups, and the deflection of the flexible joint on the Lower Marine Riser Package (LMRP) of a subsea blowout preventer stack.

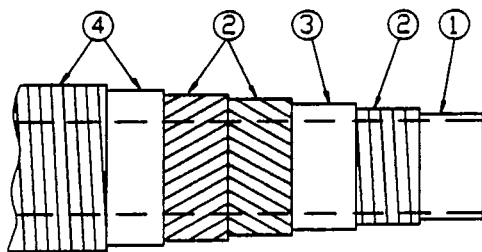
**9.14.1 DESIGN REQUIREMENTS.** Calculation and design methods shall meet sound engineering practice. These requirements are in addition to the requirements of Section 3.

**9.14.2 PRESSURE-TEMPERATURE INTEGRITY.** Flexible lines shall be capable of withstanding rated working pressures at the rated temperature without deformation to the extent that other performance requirement can not be met. See Table 3.4.3 for Rated Working Pressures and Table 3.5.2.1 for Temperature Ratings.

**TABLE 9.14.3**  
**FLEXIBLE LINE SIZES & RATED WORKING PRESSURES**

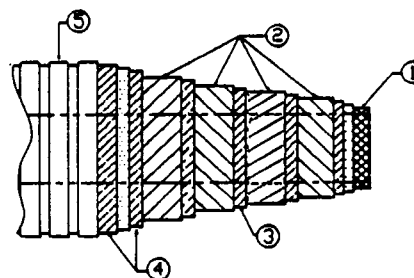
Inside diameter <i>in. (mm)</i>	Rated working pressure <i>psi (MPa)</i>	Test pressure <i>psi (MPa)</i>	Minimum burst pressure <i>psi (MPa)</i>
2 (50,8)	5000 (34,5)	10,000 (69,0)	15,000 (103,5)
3 (76,2)			
3 ½ (89)			
4 (101,6)			
2 (50,8)	10,000 (69,0)	15,000 (103,5)	22,500 (155,0)
2 ½ (63,5)			
3 (76,2)			
4 (101,6)			
2 (50,8)	15,000 (103,5)	22,500 (155,0)	33,750 (233,0)
2 ½ (63,5)			
3 (76,2)			
2 (50,8)	20,000 (138,0)	30,000 (207,0)	45,000 (310,0)
2 ½ (63,5)			
3 (76,2)			

#### 9.14.4 TYPICAL FLEXIBLE LINE CONSTRUCTION



**NON-BONDED FLEXIBLE LINE**

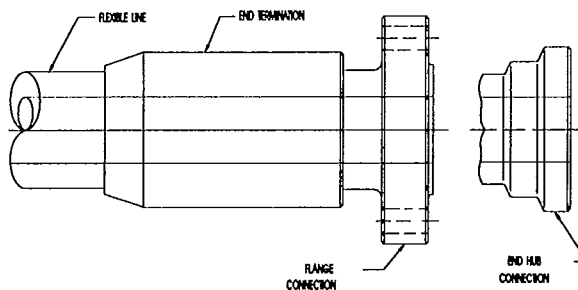
1. FLUID CONTAINING INNER TUBE
2. REINFORCEMENT WINDINGS
3. INTERMEDIATE SHEATH
4. OUTER JACKET



**BONDED FLEXIBLE LINE**

1. FLUID CONTAINING INNER TUBE
2. REINFORCEMENT WINDINGS
3. HIGH TENSILE FABRIC
4. CUSHION AND COVER
5. OUTER JACKET

#### 9.14.5 TYPICAL FLEXIBLE LINE END TERMINATION



**9.14.6 END CONNECTIONS.** Flexible Choke and Kill Line end connections shall be of welded or one piece pipe design and the pressure rating shall be equivalent to the pressure rating of the flexible line. End connections shall meet the requirements of Section 9.5. Pipe threads are not acceptable end connections.

**9.14.7 END TERMINATION.** The flexible Choke and Kill Line end termination shall be in accordance with the manufacturers' written specification, which shall as a minimum include the requirements of this specification.

**9.14.8 MINIMUM BEND RADIUS.** The minimum bend radii (MBR) at rated working pressure shall be in accordance with manufacturers' written specification.

**9.14.9 LENGTH TOLERANCE.** The standard overall length tolerances of flexible lines 20 feet (6000 mm) and under shall be  $\pm 2 \frac{1}{2}$  inches (6,5 mm) with the tolerance of longer lines being  $\pm 2\%$ . The standard tolerance for length change from atmospheric to working pressure is a maximum of  $\pm 2\%$  of the overall length.

The length tolerance for LMRP Choke and Kill Lines is to be specified by the manufacturer, after length and orientation modeling are completed.

**9.14.10 COLLAPSE RESISTANCE.** Flexible lines subjected to subsea service shall be designed to withstand the external pressure for the operational depth without deforming to a point where they can no longer function as the design specifies. Collapse resistance will meet manufacturer's written specifications.

**9.14.11 MATERIAL REQUIREMENTS.** The following material requirements are in addition to the requirements of Section 4. Metallic and non-metallic materials used in flexible lines require a written material specification.

**9.14.11.1 Metallic Materials For Flexible Line Assemblies.** The manufacturer's written specifications for all pressure containing (wetted and non-wetted) metallic materials shall be in accordance with Section 4.1.1.

**9.14.11.2 Non-Metallic Materials For Flexible Line Assemblies.** The manufacturer's written specifications for non-metallic materials shall define:

1. Chemical testing requirements and tolerances.
2. Mechanical testing requirements and tolerances.
3. Traceability requirements.

**9.14.12 PERFORMANCE VERIFICATION TESTS.** Successful completion of verification testing qualifies the size and smaller sizes of identical construction and material for the specific rated working pressure and temperature rating. The minimum tests required for performance verification approval are shown below.

**9.14.12.1 HYDROSTATIC INTERNAL PRESSURE, BENDING FLEXIBILITY, AND BURST TEST**

**Hydrostatic Internal Pressure —** A minimum length of ten feet, including the end fittings, shall be used for this test. The flexible line shall be pressurized to test pressure and held for one hour. The test will

be conducted at room temperature and the temperature shall be recorded. The flexible line shall then be pressure cycled a minimum of 260 pressure cycles, 0 psi to rated working pressure. The rated working pressure shall be held for five minutes duration per cycle. There shall be no visible leakage.

**Bending Flexibility Test —** Upon completion of the hydrostatic internal pressure test and with no pressure on the line, the line is bent to the manufacturer's specified working minimum bending radius. The line shall be bent to a minimum 90° to the specified working minimum bend radius. The line will be subjected to the minimum rated temperature, reference Section 3.5.2, and bent for a minimum 100 cycles.

The line will then be brought back to room temperature and bending cycle tests continued for a minimum 260 cycles. The line sample is then pressurized to rated working pressure and is bent to the manufacturer's specified working minimum bending radius for a minimum 260 cycles. There shall be no visible leakage.

If the bend radius for storage differs from working minimum bend radius, test shall be repeated for storage minimum bend radius with no pressure applied.

**Burst Test —** Upon completion of the bending flexibility test, the line is pressurized to failure at a rate not exceeding 1500 psig per minute. During the pressure application to burst, there shall be no visible leakage in the line body or the termination. Acceptance criteria shall be burst at or above minimum burst pressure as specified in Table 9.14.3.

**9.14.12.2 EXPOSURE TEST.** The tests evaluate the effects of gas permeation, gas decompression, and test fluid exposure at rated temperature.

The tests shall be conducted in two series. Series 1 requires three short term exposures to standard test fluid in Table 9.4.4. Series 2 requires two long term exposures to the same test fluid.

All tests will be conducted on the same flexible line sample with a minimum ten feet length, including the end fittings. No device shall be introduced to the bore that would support or restrain the bore from reacting to the test medium.

**Series 1.** The line shall be pressurized three separate times to the rated working pressure (+0,-500 psi, 3,4 MPa, or -5%, whichever is less) and rated temperature ( $\pm 10^\circ\text{F}$ ,  $\pm 5,6^\circ\text{C}$ ). The first pressurization shall be held for 24 hours. The second and third pressure applications shall be held for 12 hours. After each cycle, the line shall be vented at 1,000 psi (6,9 MPa) per minute ( $\pm 100$  psi (0,69 MPa) per minute) and held for at least one hour at atmospheric pressure between pressure applications.

Following completion of Series 1 testing, the flexible line must maintain the minimum ID as per manufacturer's written specification.

**Series 2.** The line shall be pressurized to rated working pressure (+0,-500 psi, 3,4 MPa, or -5%, whichever is less) and rated temperature ( $\pm 10^\circ\text{F}$ ,  $\pm 5,6^\circ\text{C}$ )

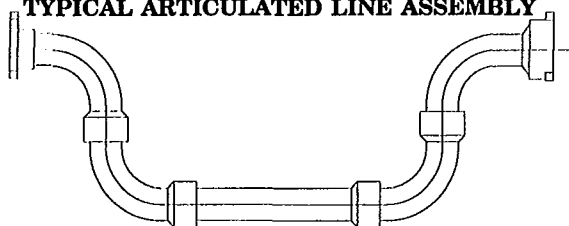


and held for seven days. After exposure, the line shall be cooled to room temperature. After cooling, the pressure shall be adjusted to the rated working pressure. The pressure shall be held for 30 days at room temperature.

Following the 30 day exposure, the assembly shall be pressurized with water to at least the test pressure specified in Table 9.14.3. The test pressure shall be held for 30 minutes. For acceptance, the assembly shall have no visible leakage nor be damaged in any way affecting normal usage.

## 9.15 ARTICULATED CHOKE & KILL LINES

FIGURE 9.15.1  
TYPICAL ARTICULATED LINE ASSEMBLY



**9.15.2 ARTICULATION.** The degree of relative movement allowed between the end points shall be defined in the manufacturer's written specification.

**9.15.3 PERFORMANCE VERIFICATION OF ARTICULATED CHOKE & KILL LINE ASSEMBLY.** The dynamic ability of the Articulated Choke and Kill Line assembly shall be proven by testing. The tests shall be at rated working pressure on an articulated line assembly containing at least three swivel joints. The test shall rotate the assembly through a minimum 45° angle, in two planes, for at least 620 cycles. Series 1 & Series 2 Test shall use the test fluid of Section Table 9.4.4 and the temperatures of Section 3.5.2.

**Series 1.** The assembly shall be pressurized three separate times to the rated working pressure (+0,-500 psi, 3,4 MPa, or -5%, whichever is less) and rated temperature ( $\pm 10^{\circ}\text{F}$ ,  $\pm 5,6^{\circ}\text{C}$ ). The first pressurization shall be held for 24 hours. The second and third pressure applications shall be held for 12 hours each. After each pressurization, the assembly shall be vented at 1,000 psi (6,6 MPa) per minute ( $\pm 100$  psi, 0,69 MPa) and held for at least one hour at atmospheric pressure between pressure applications. For acceptance, the assembly shall have no visible leakage nor be damaged in any way affecting normal usage.

**Series 2.** The assembly shall be pressurized to rated working pressure (+0,-500 psi, 3,4 MPa, or -5%, whichever is less) and rated temperature ( $\pm 10^{\circ}\text{F}$ ,  $\pm 5,6^{\circ}\text{C}$ ) and held for seven days. After exposure, the assembly shall be cooled to room temperature. After cooling, the pressure shall be adjusted to the rated working pressure. The pressure shall be held for 30 days at room temperature. There shall be no visible leakage during the test.

Following the 30 day exposure, the assembly shall be pressurized with water to at least the test pressure specified in Table 9.14.3. The test pressure shall be held for 30 minutes. For acceptance, the assembly shall have no visible leakage nor be damaged in any way affecting normal usage.

**9.15.4 MARKING.** Articulated lines conforming to this specification shall be marked with the information at the locations detailed in Table 7.3.1.

## 9.16 HYDRAULIC CONTROL SYSTEM, DRILLING CHOKES

**9.16.1 DESIGN.** The drilling choke control system, at maximum output, shall fully open or close the choke within 30 seconds. The output pressure of the hydraulic pump shall be limited to the rated working pressure of the control system. The pump system shall have a storage reservoir with a volume at least ten times (10X) the capacity of the hydraulic drilling choke control system, excluding the reservoir. The reservoir volume need not exceed 10 gallons, but may at the manufacturer's option. The reservoir shall have a visual hydraulic oil level indicator.

**9.16.2 PUMP CAPACITY WITH ACCUMULATOR IN SYSTEM.** The pump volumetric capacity shall be sufficient to close the choke within 20 seconds.

**9.16.3 PUMP CAPACITY WITHOUT ACCUMULATOR IN SYSTEM.** The pump volumetric capacity shall be sufficient to close the choke within 30 seconds.

**9.16.4 HYDRAULIC SYSTEM PRESSURE RATING.** The hydraulic circuit shall contain a pressure relief valve or a pressure regulating valve. Hydraulic system components and piping shall be designed with a rated working pressure at least equal to the maximum pressure setting of the pressure regulating valve. The pressure relief valve shall have a pressure setting not to exceed 10% above the rated pressure of the regulating valve. The piping and components used as return lines are not covered by this specification.

**9.16.5 TEMPERATURE RATINGS.** Components of the choke control system, including power oil shall be capable of functioning as a system at temperature of 20°F (-6,7°C) to 200°F (93,3°C), if none of the control system components are subjected to well fluids. If any components are subjected to well fluids, that components shall conform to the applicable temperature ratings of Section 3.5.2.

**9.16.6 ACCUMULATORS.** Accumulators, when installed in choke control systems, shall meet the following requirements:

**Design Code** — Accumulators shall meet the requirements of ASME Boiler and Vessel Code, Section XIII, Division 1.

**Rated Working Pressure** — Accumulators shall have a rated working pressure equivalent to the hydraulic system rated working pressure.

**Accumulator Volumetric Capacity** — As a minimum, the accumulator system shall have volumetric capacity to operate the choke from fully open, to fully closed and return to fully open.

**9.16.7 REMOTE ACTUATION BACKUP SYSTEM.** The drilling choke hydraulic control system shall be designed with a backup operating system to open or close the drilling choke after loss of primary power. The backup hydraulic system shall have a rated working pressure equal to or greater than the primary hydraulic pump.

**9.16.8 MATERIALS.** Materials in the control system that are isolated from well fluids shall be in accordance with the manufacturer's written specification, including acceptance criteria.

**9.16.9 CONTROL SYSTEM RIGID LINES REQUIREMENTS.** Drilling choke control system rigid lines shall meet the general requirements of Section 3 and the specific requirements of Section 9.

**9.16.10 CONTROL LINES FLEXIBLE REQUIREMENTS.** Drilling choke control system flexible lines are a component part of the hydraulic lines connecting the valves and the hydraulic drilling choke control unit. Flexible control system lines shall meet the requirements of SAE J 517.

**9.16.11 DESIGN VERIFICATION.** A burst test shall be conducted on an assembly representative of the finished product including identical components used in the final assembly.

**9.16.12 RETAINED FLUIDS.** The inner bore of the flexible line assembly shall be designed to withstand continuous exposure to water, water glycol, emulsified

oils, and petroleum based hydraulic fluid. Flexible lines shall meet requirements of SAE J 517 as applicable.

**9.16.13 CONNECTIONS.** Flexible control system line assemblies furnished with external threaded connections shall meet API Specification 5B.

**9.17 OPERATING MANUAL REQUIREMENTS.** The manufacturer shall prepare and have available an Operating Manual for each model and size Choke and Kill System manufactured in accordance to this specification. The operating manual shall contain the following information:

Operation and Installation Instructions

Physical Data

Seals Information

Maintenance and Testing Information

Disassembly and Assembly Information

Parts Information

Storage Information

## SECTION 10 APPENDICES

**10.1 SI/METRIC UNIT CONVERSIONS.** English measuring units are the standard in this specification. These conversion factors from API Publication 2564 are included for convenience.

**TABLE 10.1.1**  
**ENGLISH TO INTERNATIONAL SYSTEM UNITS CONVERSION**

	English	SI/Metric
<b>length</b>	1 inch	25,4 millimeters (mm)
<b>pressure</b>	1 pound/square inch (psi)	0.6894757 Bar
	14.5 psi	1 Bar
	14.5 psi	100 kilopascals (kPa)
<b>stress</b>	1 psi	0.006894757 Megapascals (MPa)
<b>impact energy</b>	1 foot-pound (ft-lb)	1.355818 Joules (J)
<b>torque</b>	1 ft-lb	1.355818 Newton-meters (N-m)
<b>temperature</b>	°F	°C = 5/9(°F-32)
<b>mass</b>	1 pound	0.4535924 kilograms (kg)
<b>volume</b>	1 gallon	3.785411 Liters (l)

**10.2 PURCHASING GUIDELINES.** This appendix provides recommended guidelines for inquiry and purchase of API Choke and Kill Systems Equipment. The purchaser should provide rated working pressure, temperature ratings and size designation, when placing an order or making an inquiry.

**10.2.1 SIZE DESIGNATION.** The size designation consists of the nominal through bore dimension. A list of standard sizes is found in Section 3 of this specification.

**10.2.2 RATED WORKING PRESSURE.** The rated working pressure is determined by the lowest rated working pressure of the component or assembly, including integral end or outlet connections. Standard rated working pressures are listed in Section 3.

**10.2.3 TEMPERATURE RATING.** The minimum temperature rating is based on the lowest ambient temperature to which the equipment may be subjected during operation. The maximum temperature rating is the highest temperature of the fluid which may flow through the equipment.

**10.2.3.1 METALLIC MATERIALS.** Metallic equipment should be designed to operate in one of the temperature ratings listed in Section 3.

**10.2.3.2 NON-METALLIC MATERIALS.** Non-metallic equipment and components, including seals,

should be designed to operate in one of the temperature ranges listed in Section 3.

### 10.3 RECOMMENDED RATED WORKING PRESSURE AT ELEVATED TEMPERATURES

#### 10.3.1 PRESSURE-TEMPERATURE DERATING.

The rated working pressures given in Table 10.3.4 are applicable for the rating given in Section 3. These rated working pressures apply only to equipment with 6B type end and outlet connections. Equipment incorporating 6BX and/or 16BX connections shall be derated by the manufacturer based on the construction materials.

**10.3.2 MARKING.** In addition to the normal marking requirements, equipment supplied for elevated temperature applications should have the derated working pressure and the applicable temperature stamped on the equipment.

**TABLE 10.3.3**  
**TEMPERATURE RATING CLASSIFICATION**

classification	operating range °F (°C)
X	0 to 350 (-18 to 177)
Y	0 to 650 (-18 to 343)

**TABLE 10.3.4**  
**PRESSURE — TEMPERATURE RATINGS — 6B CONNECTIONS**

	Temperature °F (°C)								
	250 (121)	300 (149)	350 (177)	400 (204)	450 (232)	500 (260)	550 (288)	600 (316)	650 (343)
Rated Working Pressure psi (MPa)	2000 (13,8)	1955 (13,5)	1905 (13,1)	1860 (12,8)	1810 (12,5)	1735 (12,0)	1635 (11,3)	1540 (10,6)	1430 (9,9)
	3000 (20,7)	2930 (20,2)	2860 (19,7)	2785 (19,2)	2715 (18,7)	2605 (18,0)	2455 (16,9)	2310 (15,9)	2145 (14,8)
	5000 (34,5)	4880 (33,6)	4765 (32,8)	4645 (32,0)	4525 (31,2)	4340 (29,9)	4090 (28,2)	3850 (26,6)	3575 (24,7)

## 10.4 RECOMMENDED PRACTICE FOR HEAT TREATING EQUIPMENT QUALIFICATIONS

**10.4.1 TEMPERATURE TOLERANCE.** The temperature at any point in the working zone should not vary more than  $\pm 25^{\circ}\text{F}$  ( $\pm 13,9^{\circ}\text{C}$ ) from the furnace set point temperature, after the furnace working zone has been brought up to temperature. Furnaces which are used for tempering, aging and/or stress relieving should not vary more than  $\pm 15^{\circ}\text{F}$  ( $\pm 8,3^{\circ}\text{C}$ ) from the furnace set point temperature, after the furnace working zone has been brought up to temperature.

**10.4.2 FURNACE CALIBRATION.** Heat treating of production parts should be performed with heat treating equipment which has been calibrated and surveyed.

**10.4.2.1 RECORDS.** Records of furnace calibration and surveys should be maintained for at least two years.

### 10.4.2.2 BATCH TYPE FURNACE METHODS

1. A temperature survey within the furnace working zone(s) should be performed on each furnace at the maximum and minimum temperatures for which the furnace will be used.

2. A minimum of 9 thermocouple test locations should be used for furnaces having a working zone greater than 10 cubic feet.

3. For each 125 cubic feet of furnace working zone surveyed, at least one thermocouple test location should be used up to a maximum of 60 thermocouples. See Figure 10.4.3.4 for thermocouples.

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

5. After insertion of the thermocouples, readings should be taken at least once every three minutes to determine when the temperatures of the furnace working zone approaches the bottom of the temperature range being surveyed.

6. Once the furnace temperature has reached the set point, the temperature of test locations should be recorded at two minute intervals for at least 10 minutes. Then, readings should be taken at five minute intervals, for sufficient time to determine the recurrent furnace temperature pattern — at least 30 minutes.

7. Before the set point temperature is reached, none of the temperature readings should exceed the set point by  $\pm 25^{\circ}\text{F}$  ( $\pm 13,9^{\circ}\text{C}$ ).

8. After the furnace control set point temperature is reached, no temperature should exceed the manufacturer's written specification. Each furnace within one year prior to completion of the heat treating.

9. When a furnace is repaired or rebuilt, a new furnace calibration is required before heat treating.

**10.4.2.3 CONTINUOUS TYPE FURNACE METHOD.** Continuous heat treating furnaces should be calibrated in accordance with procedures specified in Section 3, Mil-H-6875F Heat Treatment of Steels — Aircraft Practices processes.

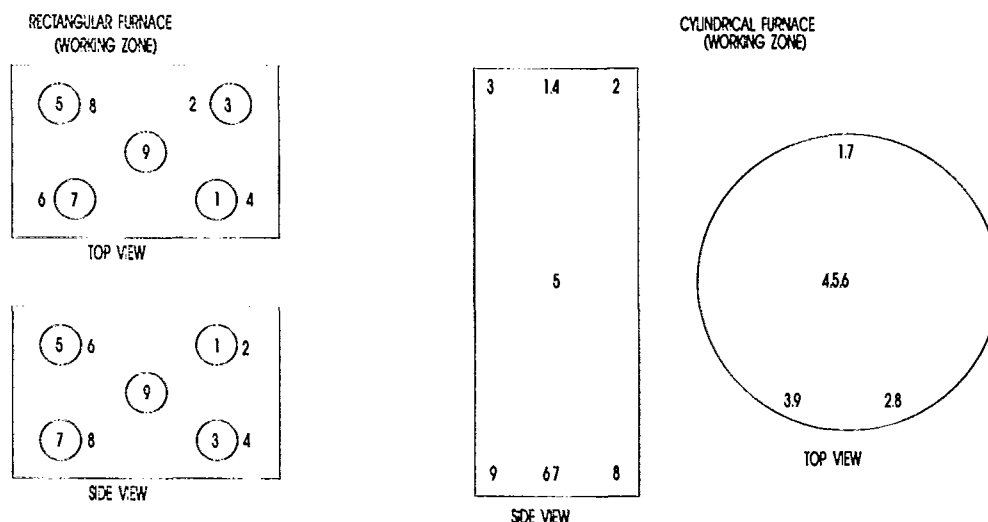
**10.4.3 INSTRUMENTS.** Automatic controlling and recording instruments should be used.

Thermocouples should be located in the furnace working zone(s) and protected from furnace atmospheres by suitable protecting devices.

**10.4.3.1 CONTROLLER ACCURACY.** The controlling and recording instruments used for the heat treatment process should provide an accuracy of  $\pm 1\%$  of the full scale range.

**10.4.3.2 CALIBRATION FREQUENCY.** Temperature controlling and recording instruments should be calibrated at least every three months.

**10.4.3.3 CALIBRATION ACCURACY.** Equipment used to calibrate the production equipment should be regularly recalibrated and have an accuracy of  $\pm 0.25\%$  of full scale range.



**FIGURE 10.4.3.4**  
**THERMOCOUPLE LOCATIONS**

**10.5 FLEXIBLE LINE TESTS****10.5.1 FLEXIBLE LINE FIRE TEST**

1. Flexible Choke and Kill Lines shall withstand a 5 to 30 minute Fire Test as described in paragraphs 2 through 6. The lines shall not have visible leakage under nominal working pressure as a result of the Fire Test during the test period.

2. The Fire Test shall consist of a direct exposure to flame or to radiation within a furnace. The temperature indicated by the thermocouples, at the end of the time period, shall be equal to or higher than 1300°F (704°C)

3. Thermocouples are to be positioned around the flexible line within 1 inch (25,4 mm) of the outer surface of the line or end fittings. At least one thermocouple near the flexible line, and one thermocouple near the surface of the end fitting shall reach 1300°F (704°C).

4. The flexible line must be pressurized full of water. The line may be tested horizontally, or vertically, according to the choice of the manufacturer.

5. The test sample shall be a minimum of 10 feet (2,5 m) long. At least 5 feet of the flexible line and one end fitting shall be exposed to the fire or radiation.

6. After exposure to the fire, the line must remain pressurized either until a cool down, or if a leak occurs after the test period, until the pressure is reduced to one atmosphere. The line must not burst during the duration of this period.

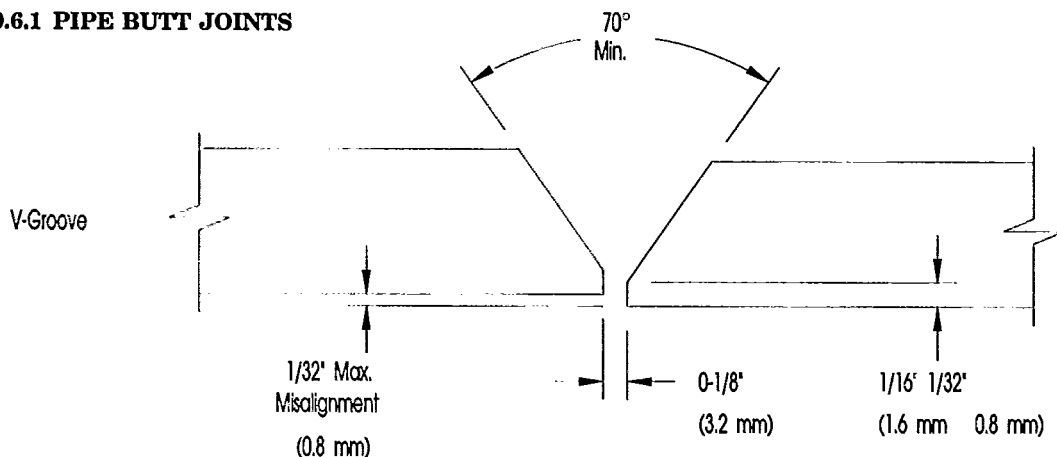
**10.5.2 FLEXIBLE LINE HIGH TEMPERATURE EXPOSURE TEST.** This test is intended to determine the maximum temperature that a flexible choke and kill line will withstand for a short duration when exposed to the rated working pressure. This test represents severe, survival conditions and should not be used to define the temperature rating of the line. It is imperative that both the line structure and the end terminations be exposed to the temperature excursions during the tests.

Upon reaching the manufacturer's rated working pressure and maximum temperature from the appropriate classification of Table 3.5.2.1, the temperature is raised at a rate not to exceed 5°F (2,8°C) per hour to 350°F, ±10°F, (177°C ±5,5°C) and held for one hour. The temperature should be measured, either at the fluid inside the line or at the inside wall of the line. At the end of one hour, the temperature is raised at a rate not exceeding 5°F (2,8°C) per hour until failure. Failure is defined as a fluid leak in the end connection, the body of the line or burst of the line. The temperature and total time of exposure to 350°F (177°C) and above should be recorded. Acceptance criteria will be sustaining the 350°F (177°C) hold period, at rated working pressure, for one hour with no visible leakage.

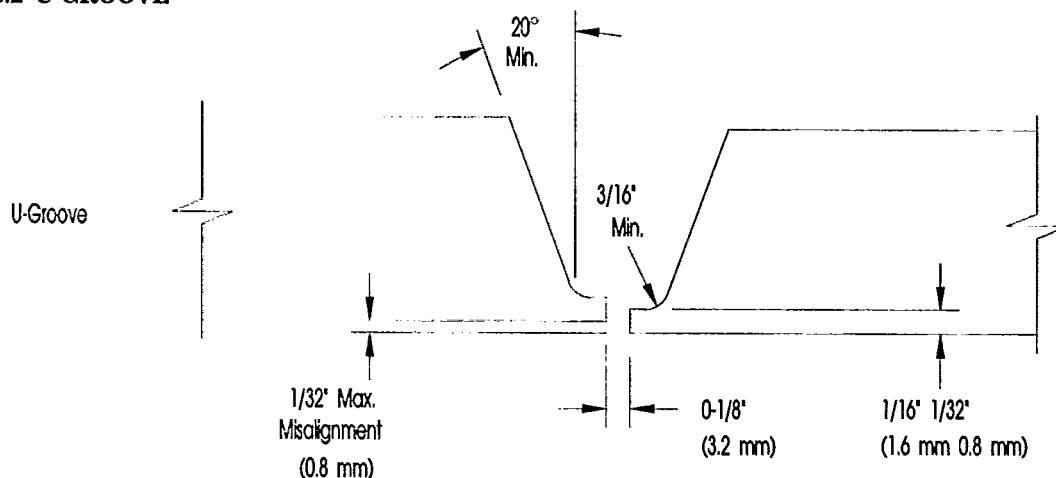
The pressurization fluid can be gas, water, or heat transfer oil. The fluid may be static or flowing. Because the objective of the testing is to simulate, as closely as possible, service conditions, line heating should be from the inside.

## 10.6 WELD PREPARATION DESIGNS

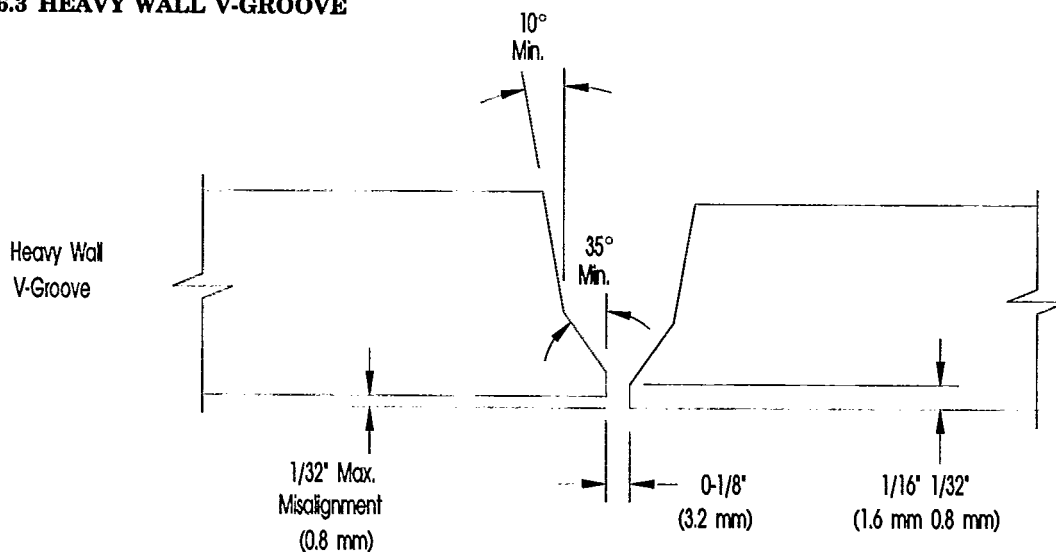
### 10.6.1 PIPE BUTT JOINTS



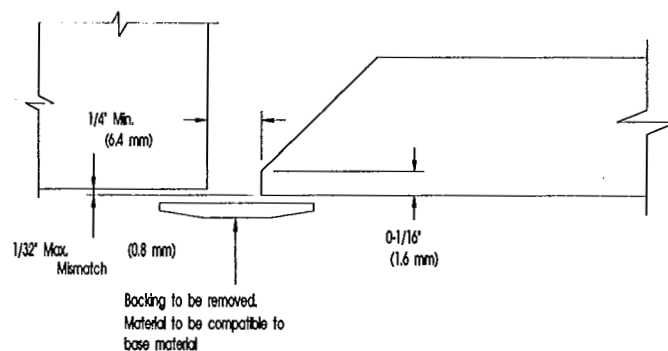
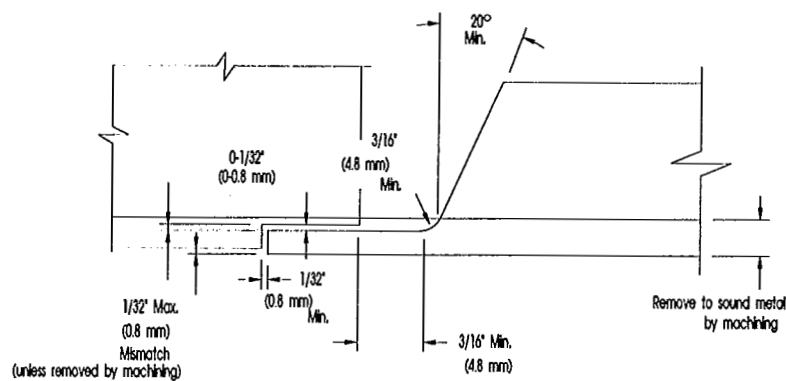
### 10.6.2 U-GROOVE



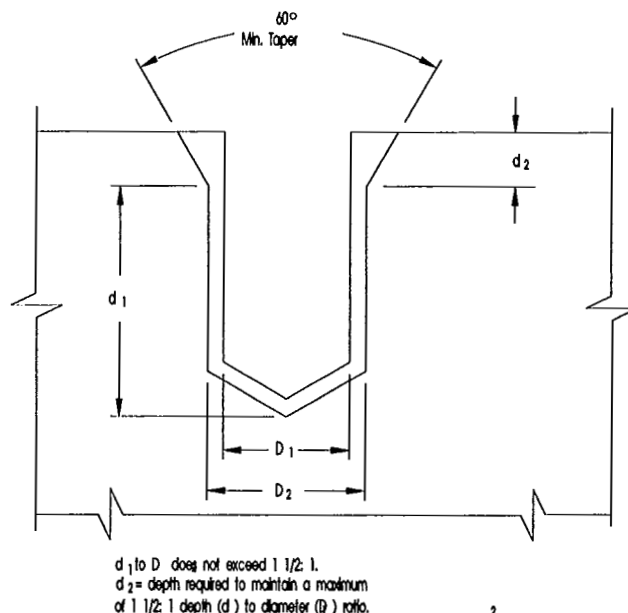
### 10.6.3 HEAVY WALL V-GROOVE

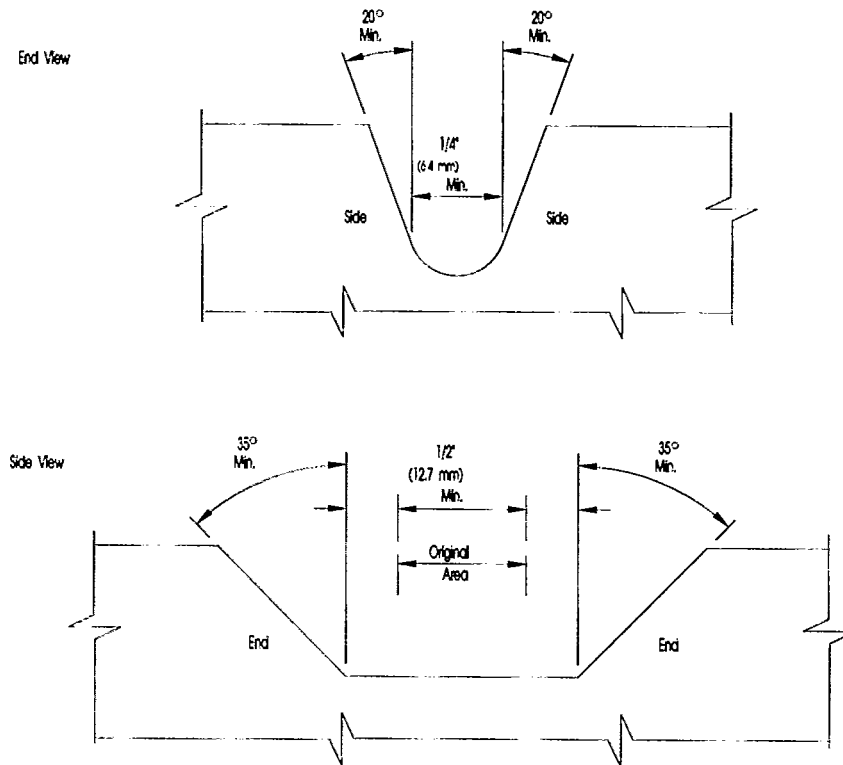


## 10.6.4 ATTACHMENT WELDS



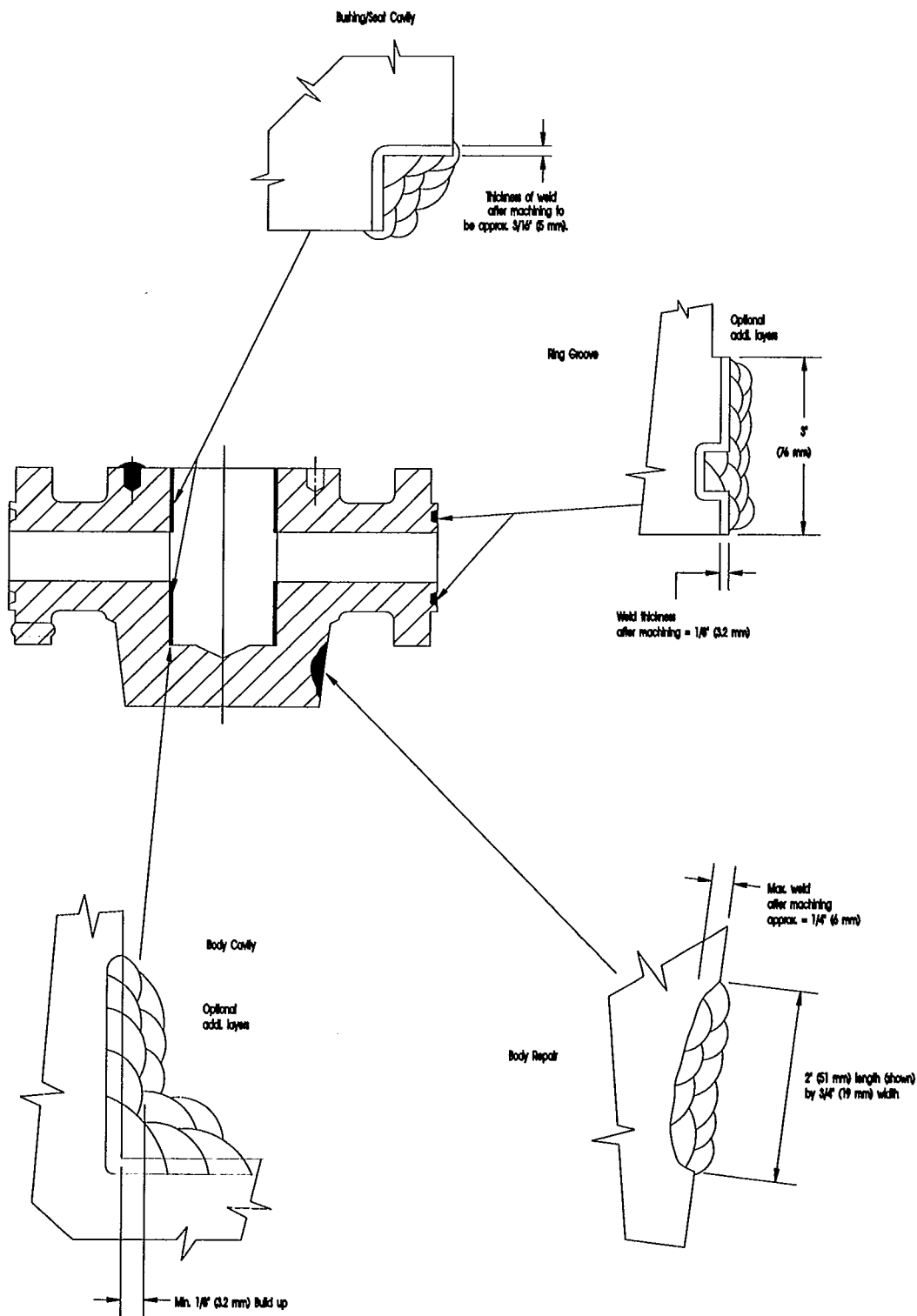
## 10.6.5 HOLE REPAIR



**10.6.6 EXCAVATION FOR REPAIR.** Removal of sample discontinuities in weld metal and base metal.



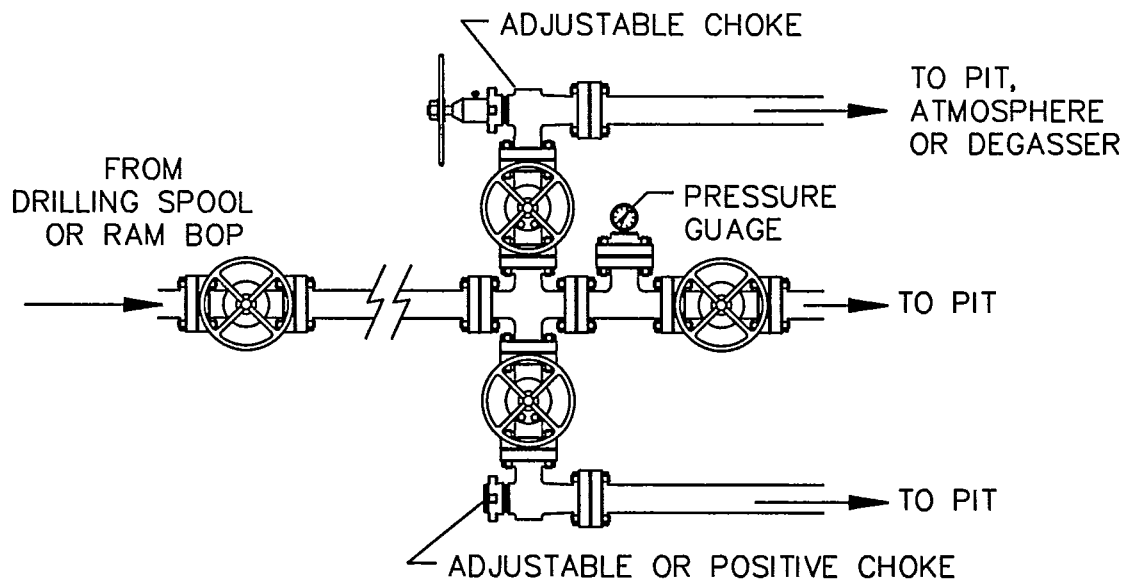
# 10.6.7 BUSHING / SEAT CAVITY



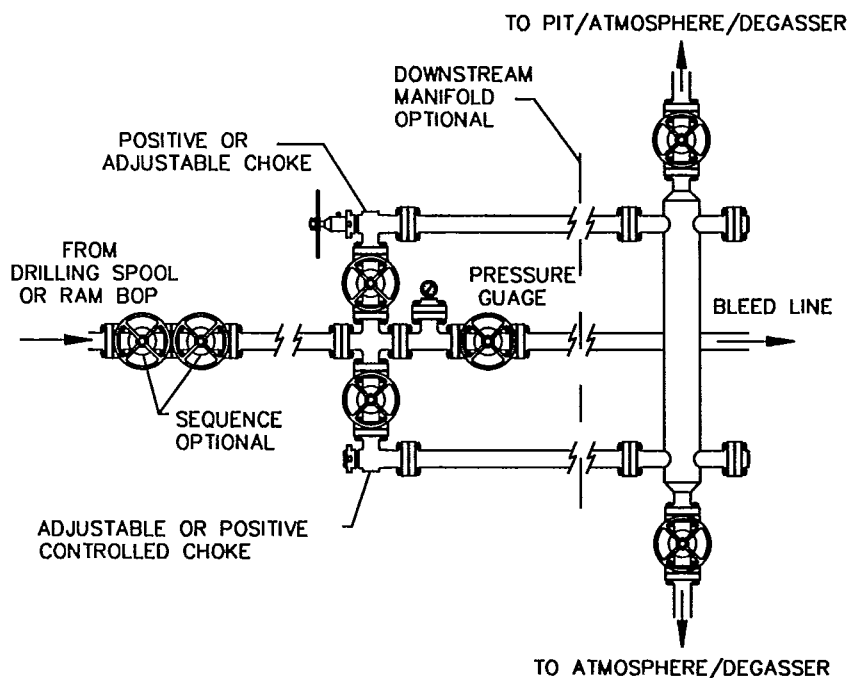
**10.7 TYPICAL CHOKE AND KILL SYSTEM CONFIGURATIONS.** This Appendix contains typical configurations of kill line, choke line, and manifold arrangements for surface and subsea applications. These configurations

are taken from API Recommended Practice RP 53 Second Edition, with the exception of the 20,000 psi rated working pressure configurations.

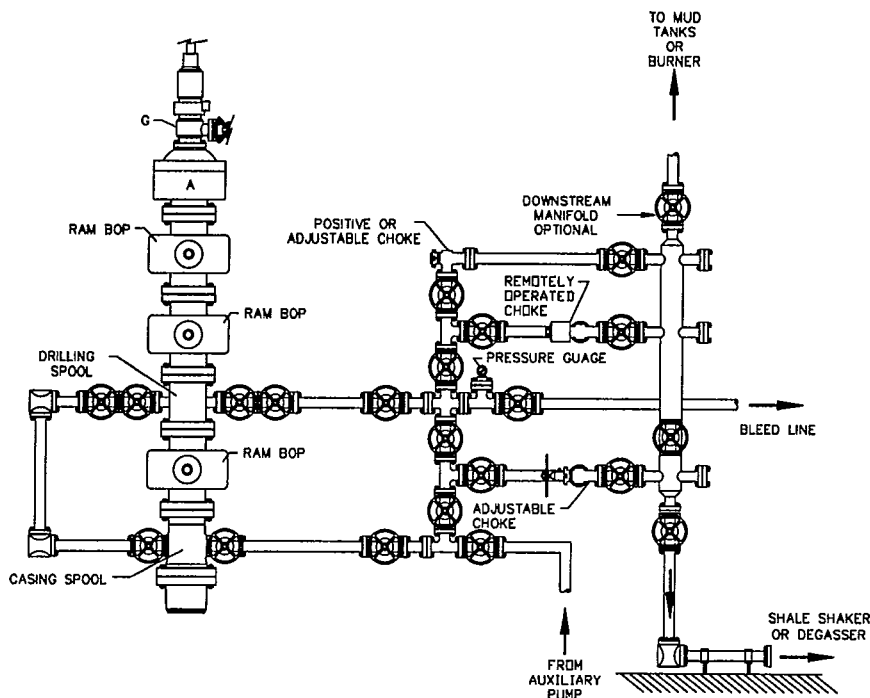
### 10.7.1 TYPICAL 2000 PSI (13,8 MPa) MANIFOLD



### 10.7.2 TYPICAL 5000 PSI (34,5 MPa) MANIFOLD



### 10.7.3 TYPICAL 10,000 (69,0 MPa) — 20,000 PSI (138,0 MPa) MANIFOLD



### 10.8 CALCULATIONS

**10.8.1 STRESS ANALYSIS — THERMAL EXPANSION.** A stress analysis should be made for a two anchor system and should meet the criterion below. The calculated stress will only be generated when the two anchor points are immovable (fixed).

$$S_{tm} = \frac{L}{A} \Delta T B E \geq S_m$$

where:

$S_{tm}$  = thermal stress (psi)

$L$  = length between fixed anchors [inches]

$\Delta T$  = temperature difference

$B$  = coefficient of thermal expansion

$E$  = Young's Modulus

$S_m$  = membrane design stress [psi]

$A$  = area square inches

**10.8.2 SCREENING GUIDELINES.** The following guidelines and ASME 31.3 Chapter 2 may help in screening pipe or systems that generally will not require thermal stress analysis:

1. Systems where the maximum temperature changes will not exceed 50°F.

2. Piping where the maximum temperature change will not exceed 75°F, provided that the distance between turns in the piping exceeds 12 nominal pipe diameters.

3. Systems which satisfy this equation.

$$\frac{D \Delta_1}{(L-U)^2} = 0.03$$

where:

$D$  = nominal pipe size [inches]

$\Delta_1$  = expansion to be absorbed by pipe [inches]

$L$  = actual length of pipe [feet]

$U$  = anchor distance [feet], straight line distance

$\Delta_1$  may be calculated by the following equation from ANSI B31.3.

$$\Delta_1 = 12LB \Delta T$$

where:

$\Delta_1$  = expansion to be absorbed by pipe [inches]

$L$  = actual length of pipe [feet]

$B$  = mean coefficient of thermal expansion at normal operating temperature

$\Delta T$  = temperature change [°F]

**10.8.3 EXPANSION LEVELS.** Pipe movement can be handled by expansion bends (including Loops — "U", "L", and "Z" shaped piping), and swivel joints. Expansion bends are preferred when practical. If expansion bends are not practical, swivel joints should be used.

**10.9 DRILLING CHOKE CONTROL CONSOLE SYSTEM.** The function of the remote hydraulic choke control system is to provide reliable control of the drilling choke from one or more remote locations with the sensitivity and resolution required to perform all well control procedures which the choke valve is designed to provide, including:

1. well flow shut-in procedures.
2. throttling of mud, gas, liquid hydrocarbons and formation debris at any rate of flow up to the physical capacity of the internal flow conduit.

**10.9.1 FUNCTIONAL REQUIREMENTS.** The control system shall provide:

1. An actuator capable of setting the orifice in the choke at any size from fully open to fully closed at any pressure up to the rated working pressure of the choke.

2. Power hydraulic fluid to the choke actuator in sufficient pressure and volume to completely close the choke from the fully open position in 30 seconds.

3. Operating controls enabling the operator to set orifice openings of any size up to fully open that will result in any annulus pressure desired ( $\pm 10$  psi) from 0 psi to the choke rated working pressure. The control device should be suitably marked for direction of control.

4. A choke position indicator that shows at the control console the relative position of the choke trim or relative orifice size as a percent of fully open.

5. A gauge on the control panel for rig air to display the air or gas pressure available to power the console pump.

6. A gauge on the control panel to display system hydraulic pressure, from the hydraulic pump or accumulator system.

7. Drill pipe and casing pressure gauges scaled 0 psi to fully rated working pressure of the choke. These gauges to be clearly marked "Drill Pipe Pressure" or "Casing Pressure" and to be independent systems from other gauge systems. Additional specification for the pressure gauge shall be:

- (1) Maximum allowable error  $\pm 0.5\%$  of full scale. Bourdon tube type gauges are required, but may be supplemented with any other type such as electronic transducer and display systems. Also, gauges of any type may be provided with full scale pressure lower than choke system rated pressure for better resolution at lower pressures; in which case, manual or automatic isolation valves shall be provided to prevent over-ranging these gauge systems.

- (2) Minimum dial scale diameter — 6". Digital readouts must be 0.5" high and visible from 10 feet in any ambient light with 10 psi resolution.

- (3) Dial scale divisions shall be 25 psi or less and gauge pointer width or configuration shall be complementary to 25 psi or less visual resolution.

- (4) At the drill pipe and casing pressure sensing locations, a pressure transmitter of the piston isolator type shall be employed to keep process fluid separated from gauge system hydraulic or pneumatic fluids.

- (5) The transmitter must have a rated working pressure and rated temperature range equal to the choke rating.

- (6) The piston isolator transmitter shall have an hydraulic oil displacement capacity equal to 1.5 times the combined volume requirement of the total hose volume and gauge tube volume, considering expansion, when at full scale pressure on the gauge. A permanent metal tag on the body should warn the user against addition hoses or gauges being driven by the transducer.

- (7) For rated working pressures up to 10,000 psi, one-to-one piston ratio may be employed. At rated pressures of 10,000-20,000, four-to-one (4:1) ratio of process pressure to gauge hydraulic oil pressure shall be required.

- (8) The 1:1 isolator shall have a sensitivity of 10 psi. The 4:1 isolator shall have a sensitivity of 25 psi at a pressure equal to mid-scale of the receiver gauge.

- (9) The piston shall be designed such that in the event of a leak in the hydraulic system and hydraulic oil loss, the piston will bump the upper limit of travel and the seal rings (or auxiliary seal) will continue to isolate the process fluid from the hydraulic system and process fluids will be prevented from entering the hydraulic pressure sensing system.

- (10) The pressure transmitter shall have materials specified for well bore retained fluids.

- (11) The connection into the rig piping shall be 6 BX flanges with no pipe threads nor welded pipe thread connections. Any welding on the transmitter or adaptor should conform to welding specifications of this document.

- (12) Unions forming a part of the transmitter shall conform to specifications elsewhere in this document.

- (13) The hydraulic oil shall be operational from  $-20^{\circ}$  to  $200^{\circ}\text{F}$ , and shall be per manufacturer's specification regarding compatibility to elastomers and metallic specifications of the transmitter.

- (14) Gauge system hoses shall have pressure rating compatible with the maximum system operating pressure.

8. Pump stroke counter/rate meter for monitoring either of two rig pumps, selected by switches, shall be incorporated into the control panel.

- (1) The pump stroke counter display shall show accumulated pump strokes and shall have capability to be reset to zero by the operator, but shall automatically reset to zero and continue counting when reaching its maximum count capacity.

- (2) A switch on the panel shall permit selection of "strokes per minute" display if both are not available simultaneously.

- (3) This spm display, if digital, shall show one stroke/minute minimum resolution.

- (4) All counter/rate meter wiring (power, pump micro switches, etc) shall be in conformance with N.F.P.A. 496, A.P.S. (all applicable agencies).

(5) If digital displays are employed, the digits shall be minimum 1/2" height and visible from 10 feet in any ambient light.

**9. Emergency operation provisions:**

(1) In the event of failure of rig air, the console control system should provide connections and fitting for accepting alternative gas power such as nitrogen bottles and the recommendations for number of bottles necessary to provide 12 hours of choke operation.

(2) Hand pump, valving, and other components necessary to permit manually applying hydraulic pressure to the choke control system, in the event of failure of the main hydraulic pump.

**10.9.2 INSTRUCTION PANEL.** The choke control console panel shall contain a panel listing instructions for choke operation in a normal mode and in emergency modes. This panel should also show procedure steps to verify system readiness.

**10.9.3 HYDRAULIC HOSES.** Hydraulic hoses for the operation of the choke should be as specified below:

1. The hoses shall have connections which will permit installation in only the correct manner, and shall be prevented from installation into the pressure gauge systems.

2. The pressure gauge hoses shall likewise have connections that assure installation in only the correct manner and shall not be capable of installation in the choke operational hydraulic circuit.

3. All hose connections should be marked on the panel and the choke.

4. Systems designed for multiple choke/control panel installation shall conform to all the preceding requirements except that in multiple control console installations, simultaneous connection of multiple drill pipe and multiple casing pressure gauges is permitted to each console respectively.

**10.9.4 OPERATION/MAINTENANCE MANUAL.**

The manufacturer shall prepare and have available an operating manual for each model and size of choke system manufactured in accordance with this specification. The operating manual shall contain the following information as a minimum:

1. Installation Instructions.

2. Operating instructions covering all normal operations required of the choke, plus complete instruction for emergency operation in the event of failure of external power or equipment, and failure of any internal components.

3. Dimensions and physical data of major components.

4. Repair, maintenance, and testing information and procedures, including disassembly and assembly information.

5. Parts Information.

6. Storage Information.

**10.10 MARKING.** Equipment manufactured in accordance with this specification shall be marked in accordance with the procedures and requirements of this section. The API Specification 16C identity shall be applied only as specified and only by manufacturers who meet all the requirements of this specification. Equipment manufactured in accordance with API Specification 6A or API Specification 16A shall be marked in accordance with the procedures and requirements of that specification.

**10.10.1 LOW STRESS AREA MARKING.** For identification on low stress areas (such as nameplates, outside diameters of flanges, etc.), the use of sharp "V" stamping is acceptable.

**10.10.2 HIGH STRESS AREA MARKING.** For identification on high stress areas, dot, vibration or round "V" stamping is acceptable. Sharp "V" stamping is allowed in high stress areas only if subsequent stress relieving is performed to the component.

## 10.10.3 EQUIPMENT SPECIFIC MARKING

**TABLE 10.10.1**  
**METALLIC MARKING REQUIREMENTS (MONOGRAM LICENSEES)**

	articulated lines swivel joints unions rigid piping	flexible C & K lines	drilling choke	drilling choke actuators	C & K manifold assembly
api monogram <sup>3</sup> $\Phi$	OD	termination OD	Nameplate <sup>1</sup>	Nameplate	Nameplate
assembly serial number	NA	NA	Body and Nameplate	Nameplate	NA
connector size	OD	connector OD	connector OD	NA	NA
date of manufacture (month & year)	OD	termination OD	Body or Nameplate	Body or Nameplate	Nameplate
flow direction	NA	NA	Body	NA	NA
mfg. name or mark	OD	termination OD	Nameplate	Nameplate	Nameplate
rated working pressure	OD	termination OD	Nameplate & termination OD	NA	Nameplate
ring gasket type & number	OD	connector OD	connector OD	NA	NA
schedule/grade	OD	NA	NA	NA	NA
safety clamp	NA	termination OD <sup>2</sup>	NA	NA	NA
size	OD	termination OD	Nameplate	Nameplate	NA
thread size	NA	NA	Adjacent to Thread	NA	NA
temperature rating	OD	termination OD	Nameplate and Body	Nameplate and Body	Nameplate
test pressure	OD	termination OD	NA	NA	Nameplate
orifice area	NA	NA	Body & Nameplate	NA	NA

<sup>1</sup> Nameplate marking requirements are satisfied by body marking.

<sup>2</sup> Safety clamp location notation shall be within three feet of the end termination.

<sup>3</sup> API Licensees only.

**10.10.4 HARDNESS MARKING FOR BODIES, BONNETS, AND FLANGES.** When hardness tests are required, the actual value of the hardness test shall be stamped on the part adjacent to the test location.

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