Specification for Rotating Control Devices

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1 Scope

1.1 Purpose

This specification is developed to provide for the safe and functionally interchangeable rotating control devices (RCDs) utilized in air drilling, drilling operations for oil and gas, and in geothermal drilling operations.

Technical content provides requirements for design, performance, materials, tests and inspection, welding, marking, handling, storing, and shipping. This specification does not apply to field use or field-testing of RCDs.

Critical components are those parts having requirements specified in this document.

If product is supplied bearing the API Monogram and manufactured at a facility licensed by API, the requirements of Annex A apply.

1.2 Applications

1.2.1 Equipment

An RCD is considered a complete system when comprised of subcomponents that allows for rotation and axial movement of drill string while simultaneously containing wellbore pressure. Specific equipment covered by this specification includes but not limited to:

a) active, passive, and hybrid rotating control devices (see Figure 1, Figure 2, and Figure 3) illustrate a surface BOP stack-up with each type of RCD installed);

b) RCD bearing assemblies including metallic and non-metallic parts;

c) RCD packer units (active and passive types);

d) RCD housing clamps or locking mechanisms.

1.2.2 Interchangeability

Dimensional interchangeability is limited to end and outlet connections per API 6A and API 16A.

1.2.3 Service Conditions

Service conditions refer to classifications for pressure, temperature, and wellbore fluids listed in 4.2 for which the equipment is designed.

1.3 Product Specification

This specification establishes requirements for products listed in 1.2.1.

1.4 Units and Dimensioning

For the purposes of this specification, the decimal/inch system is the standard for the dimensions shown. API size designation is shown as fractions. For the purposes of this specification, the fractions and their decimal equivalents are equal and interchangeable.

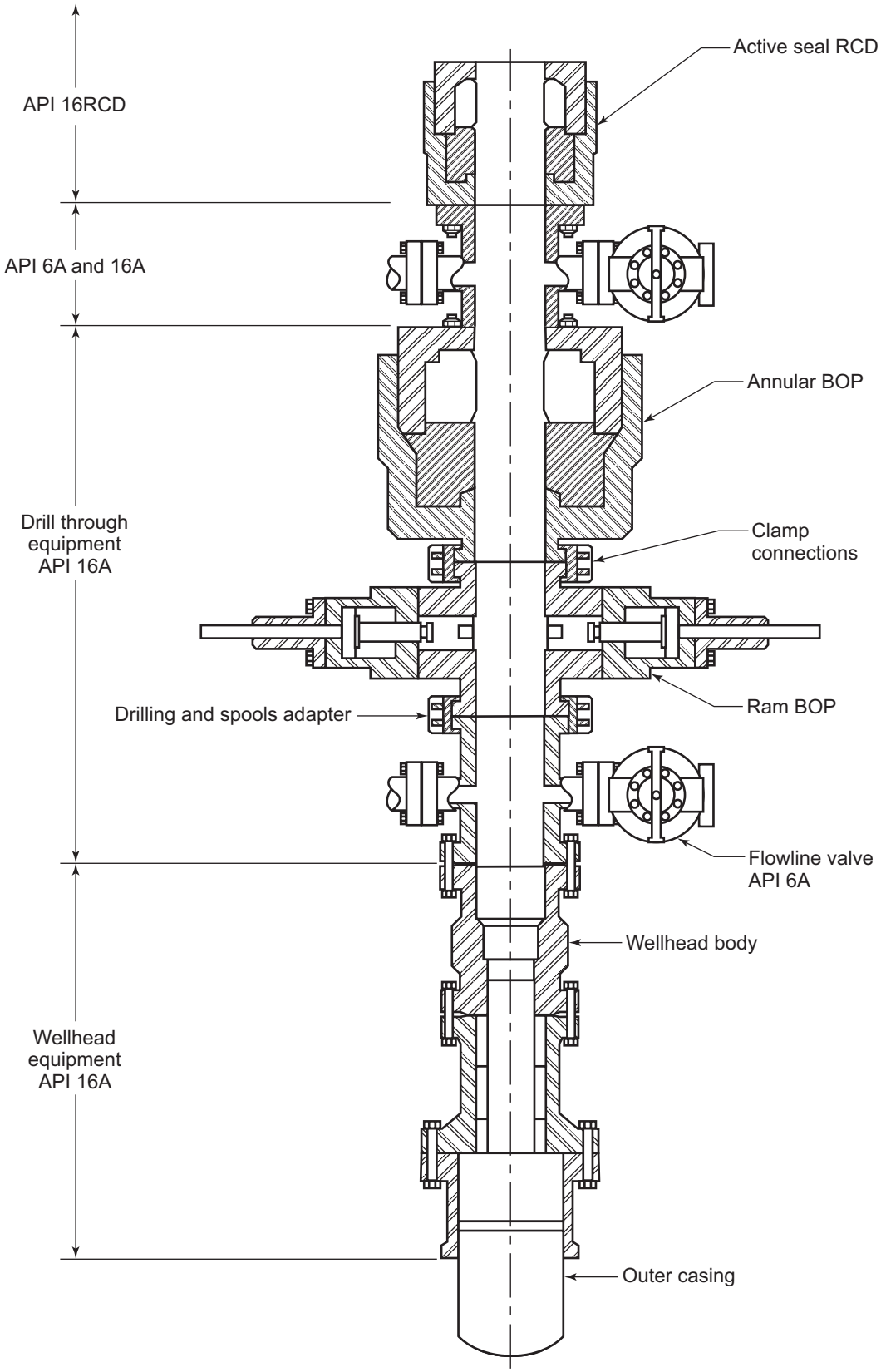

Figure 1—Typical Surface Stack illustrating an Active Rotating Control Device

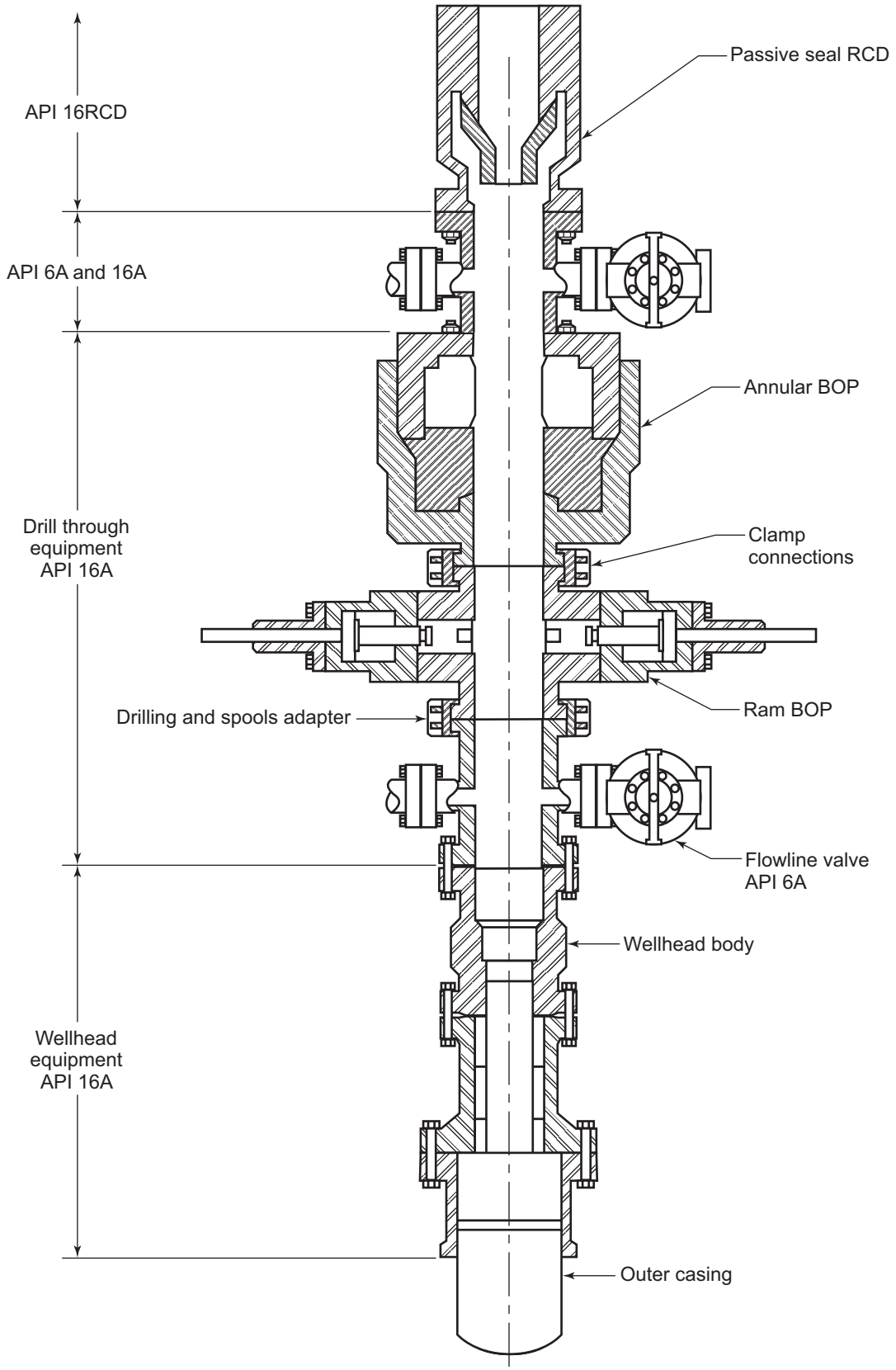

Figure 2—Typical Surface Stack illustrating a Passive Rotating Control Device

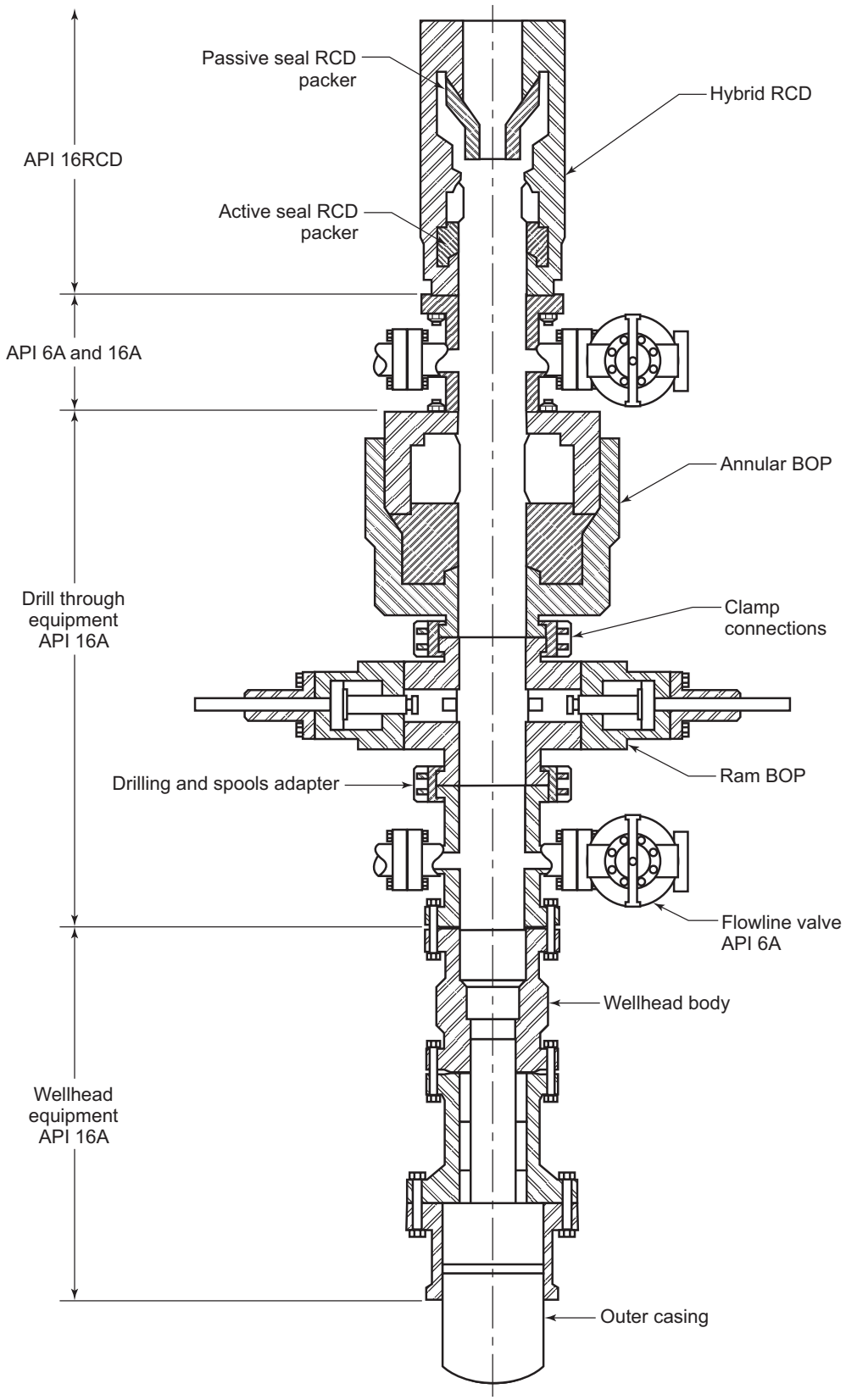

Figure 3—Typical Surface Stack illustrating a Hybrid Rotating Control Device

1.5 Metric Conversions

Metric conversions are described in Annex G of API 16A, and Annex F of this document.

1.6 Annexes

Annexes to this specification are not identified as requirements. They are included only as guidelines or information.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Manufacturers electing to use other nationally or internationally recognized standards in lieu of a referenced standard are responsible for documenting equivalency.

API Specification 6A, *Specification for Wellhead and Christmas Tree Equipment*

API Specification 16A, *Specification for Drill Through Equipment, 3rd Edition, June 2004*

API Technical Report 6AF2, *Technical Report on Capabilities of API Integral Flanges Under Combination of Loading—Phase II*

ASTM D1418 [1], Standard *Practice for Rubber and Rubber Lattices—Nomenclature*

NACE MR0175/ISO 15156 [2], *Petroleum and natural gas industries—Materials for use in H_2S-containing environments in oil and gas production*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

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

3.1.1
acceptance criteria
Defined limits placed on characteristics of materials, products, or services.

3.1.2
active RCD system
An RCD system wherein external pressure is supplied to maintain the seal between the seal element and the drill pipe.

3.1.3
body
Any portion of equipment between end connections, with or without internal parts, which contains wellbore pressure.

NOTE This is sometimes referred to as a ***shell***.

[1] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

[2] NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77084-4906, www.nace.org.

3.1.4
bolting
Threaded fasteners used to join end or outlet connections.

3.1.5
bolting, closure
Threaded fasteners used to assemble API 16RCD pressure-containing parts other than end and outlet connections.

3.1.6
bore through the bearing
Minimum inside diameter through the bearing assembly.

3.1.7
bore through the body
The minimum inside diameter through the RCD body, including the bottom connection.

3.1.8
bore protector
Replacement for the seals or packers for protection of the inner bore of RCD, to be installed then pressure control is not required.

3.1.9
calibration
Comparison and adjustment to a standard of known accuracy.

3.1.10
casting
(noun) Object at or near finished shape obtained by solidification of a substance in a mold.
(verb) Pouring molten metal into a mold to produce an object of desired shape.

3.1.11
chemical analysis
Determination of the chemical composition of material.

3.1.12
clamp
Device with internal angled shoulders used to fasten mating hubs.

3.1.13
clamp, RCD housing
Device used to fasten and lock mating RCD body components.

3.1.14
conformance (conform)
Fulfillment of specified requirements in every detail.

3.1.15
connection, blind
End or outlet connection with no center bore, used to completely close off a connection.

3.1.16
connection, end
Flanges (studded or open face), hub connections or other end connections which are used to join together equipment and are integral to the equipment.

3.1.17
connection, loose
Flanges (studded or open face), hub connections, or other end connections which are used to join together equipment but are not integral to the equipment.

3.1.18
connection, other end
OEC
Connections that are not specified in an API dimensional specification, including API flanges and hubs with non-API gasket preparations and manufacturer's proprietary connections.

3.1.19
connections, studded
Connections in which thread-anchored studs are screwed into tapped holes.

3.1.20
complete shut-off
CSO
Complete shut-off of wellbore without tubular in wellbore.

3.1.21
data acquisition system
System for storing and/or providing permanent copies of test information, such as: strip chart recorders, circular chart recorders, or computer systems.

3.1.22
date of manufacture
Date of manufacturer's final acceptance of finished equipment.

3.1.23
dynamic pressure rating
Maximum pressure rating while including rotation of the drill string at a given RPM.

3.1.24
equipment
Any single completed unit that can be used for its intended purpose without further processing or assembly.

3.1.25
examination, visual
Examination of parts and equipment for visible defects in material and workmanship.

3.1.26
examination, volumetric nondestructive
Examination for internal material defects by radiography, acoustic emission, or ultrasonic testing.

3.1.27
flange
Protruding rim, with holes to accept bolts and having a sealing mechanism, used to join pressure-containing equipment together by bolting one flange to another.

3.1.28
forging
(noun) A shaped metal part formed by the forging method.
(verb) Plastically deforming metal, usually hot, into desired shapes with compressive force, with open or closed dies.

3.1.29
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.

3.1.30
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.

3.1.31
heat treatment
heat treating
Alternate steps of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties.

3.1.32
heat treatment load
That material moved as a batch through one heat treatment cycle.

3.1.33
hub
Protruding rim with an external angled shoulder and a sealing mechanism used to join pressure-containing equipment.

3.1.34
hybrid system
Rotating control device (RCD) that combines a passive-type packer element with a packer element that requires an external hydraulic pressure source to provide the closure force required to maintain a seal against wellbore pressures where both elements must independently maintain a seal against wellbore pressures independently, up to the full static pressure rating of the RCD.

3.1.35
hydraulic operating chamber
Any internal or integral cavity of an RCD that is used to contain a hydraulic pressure.

3.1.36
hydraulic operating system rated working pressure
Maximum hydraulic pressure at which the equipment is designed to operate.

3.1.37
hydraulic operating system recommended operating pressure
Manufacturer’s recommended operating pressure.

3.1.38
indications
Visual signs of cracks, pits, or other abnormalities found during liquid penetrant (LP) and magnetic particle (MP) examination.

3.1.39
integral
Parts which are joined by the forging, casting, or welding process.

3.1.40
leakage
Visible passage of the pressurized fluid from the inside to the outside of the pressure containment area of the equipment being tested.

3.1.41
packing element/unit
Sealing component(s) between the rotating control device and the drill string.

3.1.42
part
Individual piece used in the assembly of a single equipment unit.

3.1.43
passive RCD system
RCD system wherein no external pressure is supplied to maintain the seal between the seal element and the drill pipe.

3.1.44
personnel, qualified
Individuals with characteristics or abilities gained through training, experience, or both, as measured against the manufacturer's established requirements.

3.1.45
post-weld heat treatment
Any heat treatment subsequent to welding, including stress relief.

3.1.46
pressure-containing part(s) or member(s)
Parts exposed to wellbore fluids whose failure to function as intended would result in a release of wellbore fluid to the environment, e.g. bodies, bearing assemblies.

3.1.47
pressure-controlling part(s) or member(s)
Parts intended to control or regulate the movement of wellbore fluids, e.g. packing elements, seats with a pressure-containing member or part(s).

3.1.48
pressure-retaining part(s) or member(s)
Parts not exposed to wellbore fluids whose failure to function as intended would result in a release of wellbore fluid to the environment, e.g. closure bolts and RCD housing clamps.

3.1.49
rated working pressure
Maximum internal pressure that the equipment is designed to contain and/or control.

NOTE For an RCD, the maximum internal pressure that the equipment is designed to contain and/or control depends on the operation: dynamic—pipe rotating, stripping—pipe reciprocating or tripped but not rotating and static—no pipe movement.

3.1.50
records
Retrievable information.

3.1.51
ring grooves, corrosion resistant
Ring grooves lined with metal resistant to metal-loss corrosion.

3.1.52
rotating control device (RCD)
Drill through equipment designed to allow the rotation of the drill string and containment of pressure by the use of seals or packers that seal against the drill string (drill pipe, casing, etc.).

3.1.53
rotating speed rating
Maximum rotating speed specified at a given pressure for a specific pipe size as defined by the manufacturer.

3.1.54
serialization
Assignment of a unique code to individual parts and/or pieces of equipment to maintain records.

3.1.55
stabilized (pressure testing)
When the initial pressure decline rate decreases to within the manufacturer's specified rate.

NOTE This pressure decline can be caused by such things as changes in temperature, setting of elastomer seals, or compression of trapped air in the equipment being tested.

3.1.56
stabilized (temperature testing)
When the initial temperature fluctuations decrease to within the manufacturer's specified range.

NOTE This temperature fluctuation can be caused by such things as mixing of different temperature fluids, convection, or conduction.

3.1.57
static pressure rating
Maximum design verification pressure of a complete RCD with a new element that the equipment is designed to control with no pipe movement.

3.1.58
stress relief
Controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses.

3.1.59
stripping
Adding or removing pipe from a pressured wellbore while controlling flow from the wellbore.

3.1.60
stripping pressure rating
Maximum pressure when reciprocating or tripping but not rotating the drill string for a specific packer model.

3.1.61
surface finish
Measurement of the average roughness (RMS) of a surface.

NOTE All of the surface finishes given within this specification are to be considered maximums.

3.1.62
weld, fabrication
Weld joining two or more parts.

3.1.63
weld, full penetration
Weld which extends throughout the complete wall section of the parts joined.

3.1.64
weld groove
Area between two metals to be joined that has been prepared to receive weld filler metal.

3.1.65
welding
Fusion of materials, with or without the addition of filler materials.

3.1.66
yield strength
Stress level measured at room temperature, expressed in pounds per square in. of loaded area, at which material plastically deforms and will not return to its original dimensions when the load is released.

NOTE All yield strengths specified in this standard are considered as being the 0.2 % yield offset strength per ASTM A370.

3.2 Acronyms and Abbreviations

For the purposes of this document, the following acronyms and abbreviations apply.

ASTM	American Society for Testing and Materials
CRA	corrosion-resistant alloy
CSO	complete shut-off
ID	inside diameter
LP	liquid penetrant
MP	magnetic particle
NDE	nondestructive examination
OD	outside diameter
OEC	other end connection
PQR	Procedure Qualification Record
QTC	Qualification Test Coupons
RCD	rotating control device

4 Design Requirements

4.1 Size Designation

The size designation of equipment within the scope of this specification shall be in accordance with 4.3.

4.2 Service Conditions

4.2.1 Pressure Ratings

The static pressure rating, the dynamic pressure rating, and the stripping pressure rating shall be specified by the manufacturer and validated by this specification. All pressure ratings are for new packing elements and shall not exceed the pressure rating of the lowest rated connection exposed to well bore pressure.

4.2.2 Temperature Ratings

4.2.2.1 General

Minimum temperature is the lowest ambient temperature to which the equipment may be subjected.

Maximum temperature is the highest temperature of the fluid, which may flow through the equipment.

4.2.2.2 Metallic Materials

Equipment shall be designed for metallic parts to operate within the temperature ranges shown in Table 1.

Table 1—Temperature Ratings for Metallic Materials

Classification	Operating Range (°F)
T-75	–75 to 250
T-20	–20 to 250
T-0	0 to 250

4.2.2.3 Wellbore Elastomeric Materials

Equipment shall be designed for wellbore elastomeric materials to operate within the temperature classifications of 8.3.4.3.

Manufacturers shall specify the operating fluid environment (liquid, gas, or multiphase) and compatibility for the seals.

4.2.2.4 All Other Elastomeric Seals

Seals shall be designed to operate within the temperatures of the manufacturer’s written specifications.

Manufacturers shall specify the operating fluid environment (liquid, gas, or multiphase) and compatibility for the seals.

4.2.3 Retained Fluid Ratings

All metallic materials shall meet the requirements of NACE Standard MR0175/ISO 15156 for sour service.

4.3 Equipment-Specific Design Requirements

4.3.1 Flanged End and Outlet Connections

4.3.1.1 General

Flanged end and outlet connections shall conform to the dimensional requirements of API 6A.

The rotating control device (RCD) bottom connection pressure rating must be equal to or greater than the static pressure rating of the RCD.

The side outlet connection pressure rating must be equal to or greater than the static pressure rating of the RCD.

6B and 6BX flange connections may be used as integral connections.

6B and 6BX flanges integral to RCDs shall not contain test connections.

The manufacturer shall document the load/capacity for the flanged end and outlet connections using the same format as used for API flanges in API 6AF2. This format consists of graphs that relate pressure to allowable bending moment for various tensions. The manufacturer shall state which part of the connection contains the stress limitations that form the basis for the graphs. Analytical design methods shall conform to 4.4.

4.3.1.2 Design

4.3.1.2.1 Pressure Ratings and Size Ranges of Flange Connections

Type 6B and 6BX flange connections shall be designed for use in the combination of API size designation and pressure ratings as according with API 6A.

4.3.1.2.2 Type 6B Flange Connections

Dimensions for Type 6B integral flanges shall conform to API 6A. Dimensions for all ring grooves shall conform to API 6A.

NOTE Type 6B flange connections are of the ring-joint type and are not designed for face-to-face make-up.

The flange face on the ring-joint side shall be either flat or raised face and shall be fully machined. The nut bearing surface shall be parallel to the flange face within one degree. The flange back face shall be fully machined or spot faced at the bolt holes. The thickness after facing shall meet the dimensions of API 6A.

Type 6B flange connections may be manufactured with corrosion-resistant overlays in the ring grooves. Prior to application of the overlay, the preparation of the ring grooves shall conform to API 6A.

NOTE Other weld preparations may be employed when the strength of the overlay alloy equals or exceeds the strength of the base material.

4.3.1.2.3 Type 6BX Flange Connections

Dimensions for Type 6BX integral flange connections shall conform to API 6A. Dimensions for all ring grooves shall conform to API 6A.

NOTE Type 6BX flange connections are of the ring-joint type and are designed for face-to-face make-up.

The flange face on the ring-joint side shall be raised and shall be fully machined. The nut bearing surface shall be parallel to the flange face within one degree. The back face shall be fully machined or spot faced at the bolt holes. The thickness after facing shall meet the dimensions of API 6A.

Type 6BX flange connections may be manufactured with corrosion-resistant overlays in the ring grooves. Prior to application of the overlay, the preparation of the ring grooves shall conform to the dimensions of API 6A.

NOTE Other weld preparations may be employed when the strength of the overlay alloy equals or exceeds the strength of the base material.

4.3.2 Studded End and Outlet Connections

4.3.2.1 General

The two types of studded end and outlet connections (6B and 6BX) in this specification shall conform to API 6A.

Studded connections 6B and 6BX may be used as integral connections.

The manufacturer shall document the load/capacity for the studded connections using the same format as used for API flanges in API 6AF2. This format relates pressure to allowable bending moment for various tensions. The manufacturer shall state which part of the connection contains the stress limitations that form the basis for the graphs. Analytical design methods shall conform to 4.4.

4.3.2.2 Design

4.3.2.2.1 General

Design for studded end and outlet connections is the same specified in 4.3.1.2 except as follows.

4.3.2.2.2 Type 6B Studded Connections

Dimensions for Type 6B studded connections shall conform to API 6A as it relates to the bore size, diameter of the bolt circle, and flange outside diameter (OD).

The studded connection shall be fully machined in accordance with API 6A.

Stud bolt holes shall be sized and located to conform to API 6A. The thread form of the tapped hole shall conform to the requirements of 4.3.3. The minimum depth of the full threads in the hole shall be equal to the diameter of the stud and the maximum depth shall be in accordance with manufacturer’s written specification.

4.3.2.2.3 Type 6BX Studded Connections

Dimensions for Type 6BX studded connections shall conform to API 6A as it relates to bore size, diameter of the bolt circle, and flange OD.

The studded connection shall be fully machined in accordance with API 6A.

Stud bolt holes shall be sized and located to conform to API 6A. The thread form of the tapped hole shall conform to the requirements of 4.3.3. The minimum depth of the full threads in the hole shall be equal to the diameter of the stud and the maximum depth shall be in accordance with the manufacturer’s written specifications.

4.3.3 Studs, Nuts, and Tapped Stud Holes (Bolting)

Bolting for end and outlet connections, both studded and flanged, shall meet the requirements of API 6A.

4.3.4 Hubbed End and Outlet Connections

End and outlet hubs (16B and 16BX), if specified by the manufacturer, shall conform to the requirements of API 16A.

Clamps that shall be used in conjunction with end and outlet hubs (16B and 16BX) if specified by the manufacturer shall conform to the requirements of API 16A

Type 16B hub connections may be manufactured with corrosion-resistant overlays in the ring grooves. Prior to overlay, the ring groove shall be prepared as specified in API 6A.

4.3.5 Rotating Control Devices

4.3.5.1 Dimensions

4.3.5.1.1 API Designated Size

RCDs shall be identified by:

a) flange size (top, bottom, and outlet) and static pressure rating;

b) bore through body;

c) minimum restricted inside diameter (ID) with packing elements in place;

d) bore through bearing, if different from minimum restricted ID;

e) drift diameter with bore protector installed.

4.3.5.1.2 End-to-End Dimensions

The end-to-end dimensions for RCDs shall be the overall height from the bottom face of the bottom connection to the top face of the RCD. These dimensions shall be in accordance with the manufacturer’s written specifications.

4.3.5.2 Design Methods

Design methods shall conform to 4.4.

4.3.5.3 End Connections

End connections on all equipment within the scope of this specification shall conform to the requirements of 4.3.1, 4.3.2, 4.3.4, 4.3.8, and 4.3.9.

4.3.5.4 Outlet Connections

Outlet connections shall conform to the requirements of Sections 4.3.1, 4.3.2, and 4.3.4.

4.3.5.5 Material

Material used for pressure-containing parts or members shall conform to the requirements of Section 5.

Closure bolting and other parts shall conform to the manufacturer’s written specifications.

4.3.6 Ring Gaskets

Gaskets used for equipment manufactured to this specification shall meet all the requirements of API 6A, PSL 1.

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

4.3.7 Weld Neck Hubs

Non-API weld neck hubs are not addressed in this edition of API 16RCD.

4.3.8 Other End Connections (OECs)

4.3.8.1 General

This section provides requirements for other end connections which may be used for joining RCDs and which are not specified in API dimensional specification. OECs include API flanges and hubs with non-API gasket preparations and manufacturer's proprietary connections.

4.3.8.2 Design

4.3.8.2.1 Design Methods

OECs shall be designed in accordance with 4.4.

4.3.8.2.2 Size

OECs shall be designed with the same API size designation shown in API 16A, Table 1.

4.3.8.2.3 Bore Dimensions

The bore diameter shall conform to the minimum bore dimension shown in API 16A, Table 1.

4.3.8.3 Materials

OEC materials shall meet the requirements of Section 5.

4.3.8.4 Testing

API 16RCD equipment utilizing OECs shall successfully complete the tests required in Section 7.

4.3.9 Blind Connections

4.3.9.1 Flanges

6B and 6BX blind flanges shall conform to the dimensional requirements of API 6A.

4.3.9.2 Hubs

Dimensions of 16B and 16BX blind hubs, if specified by the manufacturer, shall conform to the requirements of API 16A.

4.3.9.3 OECs

The design and configuration of blind OECs shall conform to 4.3.8.2, 4.3.8.3, and 4.3.8.4.

4.3.10 Test, Vent, Injection, and Gauge Connections

Sealing and porting of flanges, hubs, and OECs shall conform to the requirements of API 6A.

4.4 Design Methods

4.4.1 End and Outlet Connections

End and outlet connections shall conform to the requirements of this specification.

4.4.2 Members Containing Wellbore Pressure

Pressure-containing parts or members shall be designed in accordance with API 16A.

4.4.3 Closure Bolting

Closure bolting shall be designed in accordance with API 16A.

4.4.4 Other Parts

Pressure-retaining parts and pressure-controlling parts shall be designed to satisfy the manufacturer’s written specifications and the service conditions defined in 4.2.

4.4.5 Miscellaneous Design Information

4.4.5.1 Connections

End and outlet connections below the sealing elements shall be integral.

4.4.5.2 RCD Housing Clamps

The manufacturer shall document the load/capacity for the RCD clamp connection using the same format as used for API flanges in API 6AF2. This format relates pressure to allowable bending moment for various tensions. The manufacturer shall state whether the limitation is in the stress level of the clamp or the RCD hub. Analytical design methods shall conform to 4.4.

4.4.5.3 OECs

The manufacturer shall document the load/capacity for the OEC using the same format as used for API flanges in API 6AF2. This format relates pressure to allowable bending moment for various tensions. The manufacturer shall state which part of the connection contains the stress limitations that form the basis for the graphs. Analytical design methods shall conform to 4.4.

4.5 Design Verification Testing

4.5.1 General

Design verification testing shall be performed on equipment specified in 1.2.1 and shall be described in the manufacturer’s written specification(s). Design verification testing shall not be required on API clamps, API flanges, API hubs, or API ring gaskets.

4.5.2 General

Experimental confirmation of the design shall be documented and verified as required in 4.6.

4.5.3 RCDs

Tests of the operating characteristics for RCDs shall conform to 4.7.

4.5.4 RCD Packer Units

Tests on RCD packing units shall conform to 4.7.

Design temperature verification testing on RCD packing units shall conform to 4.8.2.

4.5.5 Other End Connections (OECs)

Tests of the operating characteristics for OECs shall conform to the manufacturer's written specifications.

4.6 Documentation

4.6.1 Design Documentation

Designs including design requirements, methods, assumptions and calculations shall be documented. Design documentation media shall be clear, legible, reproducible, and retrievable.

4.6.2 Design Review

Design documentation shall be reviewed and verified by personnel other than the individual who created the original design.

4.6.3 Design Verification

Design verification procedures and results shall be documented.

4.6.4 Documentation Retention

Documentation retention for documents in Section 4 shall be for 10 years after the last unit of that model, size, and static pressure rating is manufactured.

4.7 Operational Characteristics Tests

4.7.1 General

4.7.1.1 Requirements

All testing shall be in accordance with Table 2.

4.7.1.2 Procedure

All operational characteristics tests shall be conducted using water as the wellbore fluid. Unless otherwise noted, the closing pressure shall be the pressure recommended by the manufacturer and shall not exceed the designed hydraulic operating system working pressure. The manufacturer shall document the procedure and results including temperatures. Procedures in Annex B may be used.

4.7.1.3 Acceptance Criterion

With the exception of stripping tests, the acceptance criterion for all tests that verify pressure integrity shall be no visible leakage under the test pressure.

4.7.1.4 Scaling

If scaling of size and static, dynamic and stripping pressure is utilized, scaling shall conform to Table 2. The manufacturer shall document his technical justification.

Table 2—Required Operational Characteristics Tests and Acceptable Scaling Practices

Test	RCDs
Sealing Characteristics	P_D, $S2$
Static Pressure Rating	P_S, $S2$
Dynamic Pressure Rating	P_D, $S2$
Stripping Pressure Rating	P_{ST}, $S3$ [c]
Fatigue [a]	P_S, $S2$
Temperature Verification	P_S, $S3$
Packer Access	P_S, $S2$ [b]

[a] This test does not apply to passive-type RCDs.

[b] Only closure mechanisms of functionally similar design may be scaled.

[c] If a single packer element is used for range of drill pipe (mandrel) sizes, the tests shall be performed on minimum OD and maximum OD mandrels with applicable tool joint geometries. All packer element sizes shall be tested for corresponding drill pipe size.

Legend:

P_S = Qualifies all API static pressure rating equal to and below that of the product tested. Exception: when packers of identical dimensions and material have multiple pressure ratings, they need only be tested at their maximum pressure rating.

P_D = Qualifies all API dynamic pressure rating equal to and below that of the product tested.

P_{ST} = Qualifies all API stripping pressure rating equal to and below that of the product tested.

$S2$ = Qualifies all API size designations of the product tested.

$S3$ = Qualifies only the API size designation of the product tested.

4.7.2 RCD Test Procedures

4.7.2.1 General

Safety procedures shall be in accordance with the manufacturer's written documentation.

4.7.2.2 Testing Requirements by RCD type

Table 3 outlines the test requirements for each type of RCD. Procedures in Annex B may be used.

4.7.2.3 Static Pressure Rating Test

This test shall validate the static pressure rating of the RCD. Documentation shall include a record of wellbore pressure and test mandrel size and shall include the model/part numbers of the assembly, as well as all internal and external seals per manufacturer's written specification that will be exposed to wellbore pressure.

Table 3—RCD Test Procedures

Test Required	Passive		Active		Hybrid		
	Bearing	Packer	Bearing	Packer	Bearing [1]	Passive Packer	Active Packer
Sealing Characteristics Test	NA	NA	NA	Yes	NA	NA	Yes[2]
Fatigue Test	NA	NA	NA	Yes	NA	NA	Yes[2]
Stripping Rating Test	NA	Yes	NA	Yes	NA	Yes	Yes
Stripping Life Test	NA	Yes	NA	Yes	NA	Yes	Yes
Packer Access Test	Yes		Yes		Yes		
Dynamic Pressure Rating Test	Yes [1]		Yes [1]		Yes [1]		
Static Pressure Rating Test	Yes [3]		Yes [3]		Yes [3]		

[1] If the design of an RCD is such that it functionally includes more than one bearing assembly while operating, then each bearing assembly must be tested independently.

[2] Both elements must independently maintain a seal against wellbore pressures up to the full static pressure rating of the RCD.

[3] There are no specific static pressure rating test procedures since the test is a requirement in at least one of the other test procedures.

4.7.2.4 Dynamic Pressure Rating Test

This test shall validate the dynamic pressure rating of the RCD to the manufacturer's stated wellbore pressure and corresponding rotational speed for a minimum of 100 hours. Documentation shall include a record of wellbore pressure and rotating speed of the mandrel, and shall include the model/part numbers of the assembly, including all internal and external seals per manufacturer's written specification that will be exposed to wellbore pressure.

4.7.2.5 Packer Access Test

This test shall determine the ability of the RCD to undergo repeated packer element changes without affecting operational characteristics. This test shall be accomplished by obtaining access to the packing unit and performing a static pressure rating test after every 20th packing unit access. Documentation shall include the number of cycles to failure or 100, whichever is attained first.

4.7.2.6 Stripping Pressure Rating Test

This test shall validate the stripping pressure rating of a specific model RCD packer element while stripping a minimum of 400 tool joints at the manufacturers specified stripping pressure rating. Documentation shall include a record of wellbore pressure and temperature, mandrel size and tool joint diameter, test fluid and shall include the model/part numbers of packing element.

4.7.2.7 Stripping Life Test

This test can be a continuation of stripping pressure rating test and shall determine the ability of the active and/or passive packing unit to maintain control of wellbore pressure while stripping test mandrel and tool joints through the closed packing unit without leaking fluid in excess of 1 gal/min while stripping. The stripping test shall be conducted against a maximum wellbore pressure (manufacturers specified stripping pressure rating) to qualify the element for a specific stripping pressure. Documentation shall include:

a) wellbore pressure used during the test;

b) wellbore fluid used during the test;

c) mandrel size and length and tool joint geometry (refer to Table 2);

d) record of reciprocating speed;

e) number of tool joints stripped or 1000 tool joints, whichever is attained first;

f) wellbore fluid pulled through volume measured during the test;

g) record of the temperature conditions during the test (ambient and surface temperature of mandrel).

4.7.2.8 Fatigue Test

This test shall determine the ability of an active-type RCD to maintain a 50 psi to 120 psi and rated static pressure seal throughout repeated closings and openings. Documentation shall include:

a) Packing element inside diameter (ID) after every 20th cycle vs. time up to 30 min.

b) The number of cycles to failure to maintain a seal or 364 close/open cycles and 52 pressure cycles, whichever is attained first

4.7.2.9 Sealing Characteristics Test

This test shall determine the closing pressure necessary and the maximum allowable rotational speed to maintain a seal as a function of wellbore pressures up to full dynamic pressure rating of the active-type RCD. The test is conducted on a drill pipe mandrel and on open hole conditions (non-rotating). The test is conducted on a drill pipe mandrel sized for the minimum drill pipe OD that the packer can be used with, as specified by the manufacturer. This test shall consist of four parts for the active packer element:

a) Constant Wellbore Pressure Test

This test shall determine the actual closing pressure required to maintain a wellbore pressure seal on the test mandrel. Documentation shall include a record of wellbore pressure vs closing pressure.

b) Constant Closing Pressure Test

This test shall determine the maximum wellbore pressure obtainable for a given closing pressure with the active-type RCD closed on the test mandrel. Documentation shall include a record of wellbore pressure vs closing pressure.

c) Full Closure Pressure Test

This test is required for any RCD that the manufacturer specifies as capable of complete shut-off (CSO). This test shall determine the closing pressure required to seal on the open hole at one half rated static pressure. Documentation shall include a record of wellbore pressure vs. closing pressure.

4.8 Design Temperature Verification Testing for Non-metallic Sealing Materials and Molded Sealing Assemblies

4.8.1 General

4.8.1.1 Safety

Safety procedures shall be in accordance with the manufacturer’s written documentation.

4.8.1.2 Intent of Procedure

This procedure shall verify performance of non-metallic seals and molded sealing assemblies used as pressure-controlling and/or pressure-containing members in equipment included in 1.2.1 of this specification. The intent of this procedure is to verify the performance of these components during exposure to low and high temperatures.

4.8.1.3 Procedure

All tests shall be performed at the extreme temperatures for the temperature class of the component being tested. Refer to 8.3.4.3 for the temperature classes. The test fluid used shall be specified by the manufacturer. The manufacturer shall document the procedure and results. Procedures in Annex C may be used.

4.8.1.4 Acceptance Criterion

The acceptance criterion for all pressure tests is that there shall be no visible leakage under the test pressure.

4.8.1.5 Scaling

If scaling of size and static pressure is utilized, scaling shall conform to Table 2. The manufacturer shall document his technical justifications.

4.8.2 Passive, Active, and Hybrid-types RCDs

Non-metallic seals and molded sealing assemblies in the RCD shall be tested to verify their ability to maintain a seal at the extremes of their temperature classification. Documentation shall include:

a) elastomer records as detailed in the test procedures;

b) record of the temperature of the RCD wellbore during the testing;

c) record of low-temperature test performance: a minimum of 3 pressure cycles at rated static pressure with a minimum pressurization hold time of 15 min. shall be required;

d) record of high-temperature test performance: one pressure cycle at rated static pressure with a minimum pressurization hold time of 60 min. shall be required.

4.9 Operating Manual Requirements

The manufacturer shall prepare and have available an operating manual for each model manufactured in accordance with this specification. The operating manual shall contain the following information as a minimum and as applicable:

a) operation and installation instructions;

b) physical data;

c) packers and seals information;

d) maintenance and testing information;

e) disassembly and assembly information;

f) parts information;

g) storage information (including the environmental conditions for storing rubber/elastomeric goods);

h) static, dynamic and stripping pressure rating;

i) hydraulic operating system rated working pressure;

j) hydraulic operating system recommended operating pressure;

k) CSO pressure rating for active-RCD.

5 Material Requirements

This section describes the material performance, processing, and compositional requirements for pressure-containing members. Other parts shall be made of materials which satisfy the design requirements in Section 4 when assembled into API 16RCD equipment.

All material requirements shall conform to API 16A.

6 Welding Requirements

This section describes the welding requirements for metallic components. All welding requirements shall conform to API 16A.

7 Quality Control Requirements

7.1 General

This section specifies the requirements relative to quality control to assure that the equipment, materials, and services meet this specification.

7.2 Measuring and Testing Equipment

Quality control requirements for measuring and testing equipment shall conform to API 16A. Refer to the relevant section in API 16A.

7.3 Quality Control Personnel Qualifications

Quality control requirements for personnel qualifications shall conform to API 16A. Refer to the relevant section in API 16A.

7.4 Quality Control Requirements For Equipment and Parts

Quality control requirements for equipment and parts shall conform to API 16A.

7.5 Quality Control Requirements For Specific Equipment And Parts

7.5.1 Pressure-containing and Pressure-controlling Parts

Quality control requirements for pressure containing and pressure controlling parts shall conform to API 16A. Refer to the relevant section in API 16A.

7.5.2 Studs and Nuts (Other Than Closure Bolting)

Quality control requirements for studs and nuts shall conform to API 16A. Refer to the relevant section in API 16A.

7.5.3 Closure Bolting

Quality control requirements for closure bolting shall conform to API 16A. Refer to the relevant section in API 16A.

7.5.4 Ring Gaskets

Quality control requirements for ring gaskets shall conform to the requirements of API 16A. Refer to the relevant section in API 16A.

7.5.5 Non-metallic Sealing Materials and Molded Sealing Assemblies

Quality control requirements for all non-metallic sealing materials and molded sealing assemblies including RCD packer elements shall conform to the requirements of API 16A.

7.5.6 All Other Drill Through RCD Equipment Not Covered in 7.5.1 Through 7.5.5

All quality control requirements shall be documented in the manufacturer's written specifications.

7.5.7 Assembled Equipment

7.5.7.1 General

The quality control requirements for assembled equipment shall include drift tests, pressure tests, rotating torque tests (if applicable) and hydraulic operating chamber tests. At the manufacturer's discretion, these tests can be conducted with or without a packing element.

7.5.7.2 Serialization

Serialization is required on all assembled equipment and shall be done in accordance with the manufacturer's written specification.

7.5.7.3 Traceability Record Report

A report shall be prepared in which all serialized and individual heat traceable parts are listed as traceable to the assembly (e.g. assembly part number, serial number).

7.5.7.4 Drift Test

7.5.7.4.1 General

A drift test is required on RCDs.

7.5.7.4.2 Method

Pass a drift mandrel through the bore of the assembly after all pressure testing.

Drift mandrel diameter shall be 0.020 in. to 0.030 in. less than the manufacturer's specified size designation of the bore of the bearing assembly and RCD body.

Drift mandrel gauge length shall be at least 2 in. longer than any cavity that intersects the bore, but not less than 12 in.

7.5.7.4.3 Acceptance

The drift mandrel shall pass through without being forced.

7.5.7.5 Pressure Test Equipment

A data acquisition system shall be used on all hydrostatic tests and on hydraulic control system tests. Pressure gauges used shall be as described in 7.2.3. The record shall identify the recording device and shall be dated and signed.

7.5.7.6 Hydrostatic Body Testing

7.5.7.6.1 General

All RCDs shall be subjected to a hydrostatic body test prior to shipment from the manufacturer's facility. Water or water with additives shall be used as the testing fluid. Any additives shall be documented in the test records.

7.5.7.6.2 In-plant Hydrostatic Body or Shell Test

RCDs shall be tested with its sealing mechanisms in the open position, if applicable.

The hydrostatic body or shell test pressure shall be determined by the static pressure rating for the equipment. Hydrostatic body test pressures shall be 1.5 X static pressure rating.

The hydrostatic body test shall consist of three steps:

a) the initial pressure-holding period of not less than 3 min.;

b) the reduction of the pressure to zero;

c) the second pressure-holding period of not less than 15 min.

The timing of the test shall not start until the test pressure has been stabilized within the manufacturer's specified range and the external surfaces have been thoroughly dried.

7.5.7.6.3 Rotating Torque Test

Following all pressure tests a rotating torque test shall be undertaken on bearing assembly to confirm that the torque is within the manufacturer's specification, if applicable.

7.5.7.6.4 Hydraulic Operating Chamber Test

The hydraulic operating chamber test shall be performed on each assembled RCD. This test can be conducted in conjunction with a hydrostatic body shell test.

The hydraulic operating chamber shall be tested at a minimum test pressure equal to 1.5 times the operating chamber's rated working pressure.

7.5.7.6.5 Acceptance Criterion

The acceptance criterion is that there shall be no leakage.

7.5.7.7 Closed RCD Test

7.5.7.7.1 General

If the previous tests do not adequately address all pressure containing and load bearing members of an assembled unit, then the following shall be conducted.

a) Each assembled RCD shall be subjected to a closed test after the hydrostatic body test. If the assembled RCD requires a hydraulic operating system to affect a seal, the hydraulic operating system pressure used shall be equal to or less than the manufacturer's specified operating pressure. The test fluids used for all closed tests shall meet the requirements of 7.5.7.6.1.

b) The timing of all closed RCD tests shall not start until the test pressure has stabilized.

c) Closed RCD tests shall be performed at low and high pressure with the low-pressure tests always preceding the high-pressure test.

7.5.7.7.2 Low-pressure Test

A pressure of 50 psi to 120 psi shall be applied and held below the closed RCD for a time period of not less than 10 minutes after stabilization.

7.5.7.7.3 High-pressure Test

A pressure at least equal to static pressure rating of the RCD shall be applied and held below the closed RCD for a time period of not less than 10 minutes after stabilization.

7.5.7.7.4 Complete Shutoff (CSO)

If manufacturer specifies CSO, this test shall require closing without drill pipe in the RCD, i.e. on the open hole. The high-pressure test shall be as specified in 7.5.7.7.3 except as a minimum it shall be performed at a pressure equal to half the manufacturers specified static pressure rating.

7.6 Factory Acceptance Test (FAT) Matrix

7.6.1 FAT by RCD type

Table 4 summarizes the factory acceptance tests necessary for each type of RCD.

7.6.2 Acceptance Criterion

The acceptance criterion for all pressure tests is that there shall be no visible leakage under the test pressure.

7.7 Quality Control Records Requirements

7.7.1 General

7.7.1.1 Material and Test Requirements

The quality control records required by this specification are those documents and records necessary to substantiate that all materials and equipment made to this specification do conform to the specified requirements.

Table 4—FAT Requirements

FAT Matrix	RCD Type		
Test Type	**Passive**	**Active**	**Hybrid**
Drift test	YES	YES	YES
Hydrostatic body/shell test	YES	YES	YES
Rotating torque test	YES [3]	YES [3]	YES [3]
Hydraulic operating chamber test	YES	YES	YES
Low pressure closed test	YES [1]	YES [1]	YES [1]
High pressure closed test	YES [1]	YES [1]	YES [1]
Complete shut-off test	NO	If Applicable [2]	If Applicable [2]

[1] If the previous tests do not adequately address all pressure containing and load bearing members of an assembled unit, then the test shall be conducted.

[2] If manufacturer specifies CSO, then the test shall be performed.

[3] Only required for RCD with a bearing assembly.

7.7.1.2 NACE Records 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 MR0175 requirements.

7.7.1.3 Records Control

Records required by this specification shall be legible, identifiable, retrievable, and protected from damage, deterioration, and loss.

Records required by this specification shall be retained by the manufacturer for a minimum of 10 years following the date of manufacture as marked on the equipment associated with the records.

The manufacturer shall document and retain all records for each batch of raw material used in the manufacture of RCD packers and seals. Records shall be retained for a minimum period of 5 years.

All records required by this specification shall be signed and dated. Computer-stored records shall contain originator's personal code.

7.7.2 Records to Be Maintained by Manufacturer

7.7.2.1 General

The manufacturer shall retain all documents and records as required in Section 4, Section 5, Section 6, and Section 7.

For those parts or components covered in 7.5.1:

a) weld procedure qualification record (PQR);

b) welder qualification record;

c) material test records:

1) chemical analysis,

2) tensile tests (Qualification Test Coupons (QTC)),

3) impact tests (QTC, as required),

4) hardness tests (QTC);

d) Nondestructive examination (NDE) personnel qualification records;

e) NDE records:

1) surface NDE records;

2) full penetration fabrication,

3) weld volumetric NDE records,

4) repair weld NDE records;

f) hardness test records;

g) welding process records:

1) welder identification,

2) weld procedures,

3) filler materials,

4) post-weld heat treatments;

h) heat treatment records:

1) actual temperature,

2) actual times at temperature;

i) volumetric NDE records;

j) hydrostatic pressure test records;

k) critical dimensions as defined by the manufacturer.

7.7.2.2 Closure Bolting

The manufacturer shall retain individual heat traceability records for closure bolting, as required.

7.7.2.3 Non-metallic Sealing Materials and Molded Sealing Assemblies

The manufacturer shall retain a certification of compliance for non-metallic sealing materials and molded sealing assemblies to manufacturer’s written requirements.

7.7.3 Records to Be Furnished to Original Purchaser upon Product Delivery

A manufacturer's certificate of compliance stating that equipment conforms to the current edition of API 16RCD shall be furnished to the original purchaser upon product delivery.

8 Marking Requirements

8.1 General

Only a complete RCD manufactured and tested in accordance with this specification shall be eligible for API markings in accordance with the procedure and requirements of this section, Table 5, and Annex A.

Subcomponents of a complete RCD shall include traceability markings such that they can demonstrate compliance with this document.

Table 5—Marking Requirements and Locations

Marking	Rotating Control Device	OECs [d] (Integral and Loose)	Packing Element(s)
API 16RCD (see also Annex A)	Nameplate and/or body		Manufacturer's specification
Manufacturer's name or mark	Nameplate and/or body	Manufacturer's specification	Manufacturer's specification
Model or type designation (if applicable)	Nameplate and/or body		
Serial number	Nameplate and/or body		Manufacturer's specification
API size designation	Nameplate and/or connection OD [a]	Manufacturer's specification	
Body/shell pressure rating	Nameplate and/or body	Manufacturer's specification	
Temperature rating	Nameplate and/or body	Manufacturer's specification	Manufacturer's specification
Manufacturer's part number	Nameplate and/or body	Manufacturer's specification	Manufacturer's specification
Date of manufacture	Nameplate and/or body	Manufacturer's specification	Manufacturer's specification
Hydraulic operating system rated working pressure	Nameplate and/or body (Active/hybrid systems only)		
Hydraulic operating system recommended operating pressure	Nameplate and/or body (Active/hybrid systems only)		
Hydraulic open and close ports	Manufacturer's specification (Active/hybrid systems only)		
Ring groove designation	Connection OD [a,b,c]	Manufacturer's specification [c]	
Alpha-numeric codification system (8.3.4.1)			Manufacturer's specification

[a] All API and 16BX hub connections shall be marked on the neck of the connection, ½ in. maximum from the required length of the neck. (See API 16A—Table 5, Table 6, Table 7, and Table 8, dimension "L".)

[b] All flanges shall be marked in accordance with API 6A.

[c] If the ring groove is overlaid with corrosion-resistant material, the ring groove number shall be followed with "CRA".

[d] All API 16RCD OECs shall be marked in an easily accessible and readable area selected by the manufacturer.

8.2 Types of Identification Stamping

8.2.1 Metallic Components

8.2.1.1 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.

8.2.1.2 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.

8.2.1.3 Weld Metal Overlays

Weld metal overlaid ring grooves shall be marked in accordance with API 6A.

8.2.1.4 Body or Shell Pressure Rating Identification

The manufacturer’s specified body pressure rating shall be clearly and permanently marked by means of welding, milling, casting, grinding, or forging in an easily accessible and readable area on the RCD body. Cold stamping does not meet this requirement.

8.2.2 Non-metallic Components

8.2.2.1 Wellbore Non-metallic Components

For identification of wellbore non-metallic components, such as RCD Model, RCD packers and seals, the manufacturer shall have a written procedure for affixing the required codification to the product or its package.

8.2.2.2 Non-wellbore Non-metallic Components

Identification of non-wellbore non-metallic components, such as elastomeric seals used in RCD-type RCD actuation systems shall be in accordance with the manufacturer’s written specification.

8.3 Specific Codification Requirements of Equipment

8.3.1 Gaskets

Ring gaskets shall be marked in accordance with API 6A.

8.3.2 Studs and Nuts

Studs and nuts shall be marked in accordance with API 6A.

8.3.3 Closure Bolting

Closure bolting shall be marked in accordance with the manufacturer’s written specification.

8.3.4 Packers and Seals

8.3.4.1 Wellbore Non-metallic Components

Wellbore non-metallic components, as described in 8.2.2.1, shall be marked with an alpha-numeric codification system in the following sequence AA BBBB CCCC DDDD EE. The meaning of the digits that make up this alpha-numeric number is described below.

Compound hardness (durometer)	AA
Compound (see Table 6)	BBBB
Date of manufacture (see 8.3.4.2)	CCCC
Lot/serial number (per manufacturer's specs.)	DDDD
Temperature class (see 8.3.4.3)	EE

In addition, the manufacturer's part number shall be marked on the component.

Table 6—Elastomer Compound Marking Code

Common Name	Chemical Name	ASTM Code D1418
Butyl	Isobutylene-isoprene	IIR
	Epichlorohydrin	CO
	Epichlorohydrin-ethylene oxide	ECO
Kel-F	Chloro fluoro elastomer	CFM
Hypalon	Chlorosulfonated polyethylene	CSM
EPR	Ethylene-propylene copolymer	EPM
EPT	Ethylene-propylene terpolymer	EPDM
Viton	Fluorocarbon	FKM
Natural Rubber	Polyisoprene	NR
Isoprene (Natural or synthetic)	Polisoprene	IR
Nitrile	Butadiene-acrylonitrile	NBR
Acrylic	Polyacrylic	ACM
Diene	Polybutadiene	BR
Neoprene	Polychloroprene	CR
Vistanex	Polyisobutylene	IM
Thiokol	Polysulfide	N/A
Silicone	Polysiloxanes	Si
SBR(GR-S)	Styrene-butadiene	SBR
Urethane	Diisocyanates	N/A
NOTE Compounds which are not listed above shall be marked "N/A."		

8.3.4.2 Date of Manufacture

The date of manufacture shall consist of the month, in numerical form and the last two digits of the year (e.g. October 1996 would be coded 1096 for code CCCC).

8.3.4.3 Temperature Class

The temperature class shall be per Table 7:

Table 7—Temperature Class

Lower Limit (First Digit)		Upper Limit (Second Digit)	
A	–15 °F	A	180 °F
B	0 °F	B	200 °F
C	10 °F	C	220 °F
D	20 °F	D	250 °F
E	30 °F	E	300 °F
F	40 °F	F	350 °F
G	Other	G	Other
X	(See note)	X	(See note)

NOTE These components may carry a temperature class of 40 °F to 180 °F without performing temperature verification testing provided they are marked as temperature class "XX" in accordance with this section.

EXAMPLE "EB" has a temperature class of 30 °F to 200 °F.

9 Storing and Shipping

9.1 Storing for Periods of Greater Than 30 Days

9.1.1 Draining after Testing

All equipment shall be drained after testing and prior to storage.

9.1.2 Rust Prevention

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

9.1.3 Connection Surface Protection

All connection faces and ring gasket grooves shall be protected with durable covers.

9.1.4 Hydraulic Operating System

The hydraulic operating system shall be flushed with a non-freezing, corrosion-inhibiting fluid in accordance with the manufacturer's written procedures. Ports shall be plugged prior to storing.

9.1.5 Elastomeric Seals

Elastomeric seals shall be stored in accordance with the manufacturer's written procedures.

9.1.6 Ring Gaskets

Loose ring gaskets shall be wrapped or boxed for storage and shipping.

9.2 Shipping

All equipment is to be shipped in accordance with the manufacturer’s written procedures.

Annex A
(informative)

Use of API Monogram by Licensees

A.1 Scope

The API Monogram® is a registered certification mark owned by the American Petroleum Institute (API) and authorized for licensing by the API Board of Directors. Through the API Monogram Program, API licenses product manufacturers to apply the API Monogram to new products which comply with product specifications and have been manufactured under a quality management system that meets the requirements of API Q1. API maintains a complete, searchable list of all Monogram licensees on the API Composite List website (www.api.org/compositelist).

The application of the API Monogram and license number on products constitutes a representation and warranty by the licensee to API and to purchasers of the products that, as of the date indicated, the products were manufactured under a quality management system conforming to the requirements of API Q1 and that the product conforms in every detail with the applicable standard(s) or product specification(s). API Monogram program licenses are issued only after an on-site audit has verified that an organization has implemented and continually maintained a quality management system that meets the requirements of API Q1 and that the resulting products satisfy the requirements of the applicable API product specification(s) and/or standard(s). Although any manufacturer may claim that its products meet API product requirements without monogramming them, only manufacturers with a license from API can apply the API Monogram to their products.

Together with the requirements of the API Monogram license agreement, this annex establishes the requirements for those organizations who wish to voluntarily obtain an API license to provide API monogrammed products that satisfy the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program requirements.

For information on becoming an API Monogram Licensee, please contact API, Certification Programs, 1220 L Street, N. W., Washington, DC 20005 or call 202-682-8145 or by email at certification@api.org.

A.2 Normative References

API Specification Q1, *Specification for Quality Management System Requirements for Product Manufacturing for the Petroleum and Natural Gas Industry*

A.3 Terms and Definitions

For purposes of this annex, the following terms and definitions apply:

A.3.1
API monogrammable product
Product that has been newly manufactured by an API licensee utilizing a fully implemented API Q1 compliant quality management system and that meets all the API specified requirements of the applicable API product specification(s) and/or standard(s).

A.3.2
API specified requirements
Requirements, including performance and licensee-specified requirements, set forth in API Q1 and the applicable API product specification(s) and or standard(s).

NOTE Licensee-specified requirements include those activities necessary to satisfy API specified requirements.

A.3.3
API product specification
Prescribed set of rules, conditions, or requirements attributed to a specified product which address the definition of terms; classification of components; delineation of procedures; specified dimensions; manufacturing criteria; material requirements, performance testing, design of activities; and the measurement of quality and quantity with respect to materials; products, processes, services, and/or practices.

A.3.4
licensee
Organization that has successfully completed the application and audit process and has been issued a license by API.

A.3.5
design package
Records and documents required to provide evidence that the applicable product has been designed in accordance with API Q1 and the requirements of the applicable product specification(s) and/or standard(s).

A.4 Quality Management System Requirements

An organization applying the API Monogram to products shall develop, maintain, and operate at all times a quality management system conforming to API Q1.

A.5 Control of the Application and Removal of the API Monogram

Each licensee shall control the application and removal of the API Monogram in accordance with the following:

a) Products that do not conform to API specified requirements shall not bear the API Monogram.

b) Each licensee shall develop and maintain an API Monogram marking procedure that documents the marking/ monogramming requirements specified by this annex and any applicable API product specification(s) and/or standard(s). The marking procedure shall:

   1) define the authority responsible for application and removal of the API Monogram;

   2) define the method(s) used to apply the API Monogram;

   3) identify the location on the product where the API Monogram is to be applied;

   4) require the application of the licensee's license number and date of manufacture of the product in conjunction with the use of the API Monogram;

   5) require that the date of manufacture, at a minimum, be two digits representing the month and two digits representing the year (e.g. 05-12 for May 2012) unless otherwise stipulated in the applicable API product specification(s) or standard(s); and

   6) require application of the additional API product specification(s) and/or standard(s) marking requirements.

c) Only an API licensee may apply the API Monogram and its designated license number to API monogrammable products.

d) The API Monogram license, when issued, is site-specific and subsequently the API Monogram shall only be applied at that site specific licensed facility location.

e) The API Monogram may be applied at any time appropriate during the production process but shall be removed in accordance with the licensee's API Monogram marking procedure if the product is subsequently found to be out of conformance with any of the requirements of the applicable API product specification(s) and/or standard(s) and API Monogram Program.

For certain manufacturing processes or types of products, alternative API Monogram marking procedures may be acceptable. Requirements for alternative API Monogram marking are detailed in the API Policy, *API Monogram Program Alternative Marking of Products License Agreement*, available on the API Monogram Program website at http://www.api.org/alternative-marking.

A.6 Design Package Requirements

Each licensee and/or applicant for licensing must maintain a current design package for all of the applicable products that fall under the scope of each Monogram license. The design package information must provide objective evidence that the product design meets the requirements of the applicable and most current API product specification(s). The design package(s) must be made available during API audits of the facility.

In specific instances, the exclusion of design activities is allowed under the Monogram Program, as detailed in *Advisory # 6*, available on API Monogram Program website at http://www.api.org/advisories.

A.7 Manufacturing Capability

The API Monogram Program is designed to identify facilities that have demonstrated the ability to manufacture equipment that conforms to API specifications and/or standards. API may refuse initial licensing or suspend current licensing based on a facility's level of manufacturing capability. If API determines that additional review is warranted, API may perform additional audits (at the organization's expense) of any subcontractors to ensure their compliance with the requirements of the applicable API product specification(s) and/or standard(s).

A.8 API Monogram Program: Nonconformance Reporting

API solicits information on products that are found to be nonconforming with API specified requirements, as well as field failures (or malfunctions), which are judged to be caused by either specification deficiencies or nonconformities with API specified requirements. Customers are requested to report to API all problems with API monogrammed products. A nonconformance may be reported using the API Nonconformance Reporting System available at http://compositelist.api.org/ncr.asp.

Annex B
(informative)

Operational Characteristics Test Procedures Used to Define the Operating Characteristics of RCDs

B.1 General

This Annex provides recommended guidelines for operational characteristics test procedures of API 16RCD equipment.

B.2 Pressure Loss Measurement

Pressure testing on RCDs requires allowance for the pressure to stabilize before timing of the test begins.

B.3 Calibration

Each gauge or pressure transducer used shall be calibrated in accordance with 7.2.

B.4 Data Recording Technique

All tests (rotation, pressure, stripping cycles, and fatigue cycles) shall be done in conjunction with a data acquisition system. The information shall be identified, dated, and signed/verified by the tester and witnesses as applicable.

B.5 RCD Test Procedures

B.5.1 Sealing Characteristics Test (Active RCD)

The following procedure is used for conducting sealing characteristic tests on RCD.

a) Install the RCD (with only the active element and bearing installed) on the test stump. Connect opening and closing lines to the RCD. Connect line from the high-pressure test pump to the stump or the RCD side outlet.

b) The closing line and wellbore pressure line shall each be equipped as a minimum with a pressure transducer. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install the test mandrel in the RCD. Use a test mandrel of maximum and minimum diameter for each sealing element as specified by the manufacturer. Fill the RCD body to just above the top of the packer element with water.

d) Conduct constant wellbore pressure test as follows.

   1) Close RCD with manufacturer’s recommended closing or differential pressure.

   2) Apply 500 psi wellbore pressure.

   3) Lower closing or differential pressure until a leak develops and/or hydraulic control system goes into failsafe mode.

   4) Bleed off wellbore pressure and open the RCD.

   5) Repeat items 1 through 4, increasing wellbore pressure in equal pressure increments until wellbore pressure equals the static pressure rating of the RCD.

e) Conduct constant closing pressure test as follows.

1) Apply 500 psi closing or differential pressure.

2) Apply increasing wellbore pressure until leak occurs or hydraulic control system goes into failsafe mode or wellbore pressure equals the static pressure rating of the RCD.

3) Bleed off wellbore pressure and open RCD.

4) Repeat items 1 through 3, increasing closing pressure in equal increments each time until closing pressure reaches the level recommended by the manufacturer.

f) Full closure pressure test (required if the manufacturer specifies active element as capable of CSO).

1) Remove the drill pipe mandrel. Fill the RCD body to just above the top of the packer element with water.

2) Close RCD with pressure recommended by manufacturer.

3) Apply wellbore pressure of 50 psi to 120 psi and hold for 3 min. If leakage occurs, increase the closing pressure as needed. Do not exceed manufacturer's recommended maximum closing pressure.

4) Following successful low-pressure test, raise wellbore pressure to 50 % of manufacturer specified static pressure rating. Hold pressure 3 min. If leakage occurs, increase closing pressure as needed. Do not exceed manufacturer's recommended maximum closing pressure.

B.5.2 Fatigue Test (Active RCD)

The following procedure is used for conducting fatigue tests on RCD.

a) Install RCD on test stump. Connect opening and closing lines to RCD. Connect line from high-pressure test pump to the stump.

b) The closing line and wellbore pressure line shall each be equipped, as a minimum, with a pressure transducer. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install test mandrel in the RCD. The test is conducted on a drill pipe mandrel of the minimum diameter for each sealing element as specified by the manufacturer. Fill the RCD body with water to just above the top of the packer.

d) Close the RCD with the manufacturer's recommended closing pressure.

e) Apply 50 psi to 100 psi wellbore pressure, hold for 3 min., and then increase wellbore pressure to the full static pressure rating of the RCD and hold for 3 min. Bleed off wellbore pressure.

f) Open the RCD. This constitutes one pressure cycle.

g) Every 20^{th} pressure cycle, measure the ID of the packing element when the operating piston reaches the full open position (this can be determined by rapid pressure rise on the operating system pressure gauge). Then continue to measure the ID of the packer at 5 minute intervals until the packer ID reaches the bore size of the RCD or until 30 min. have elapsed. Record ID.

Repeat items d through g until packer leaks or until 364 close/open cycles (52 pressure cycles) have been completed, whichever is attained first.

B.5.3 Packer Access Test

The following procedure is used for conducting packer access tests on RCDs.

a) Install the RCD on a test stump.

b) Perform the manufacturer's recommended procedures for removing closure required for packer access.

c) Perform the manufacturer's recommended procedures, including recommended maintenance and replacement parts, for closing the packer access closure.

d) Repeat b and c 100 times (based on approximate twice a week for one year of drilling). Every 20th time, pressure test the RCD closed on the test mandrel to the static pressure rating of the RCD for a 3-min. holding period.

B.5.4 Stripping Pressure Rating Test

The following procedure is used for conducting stripping pressure rating tests on all RCD elements

a) Measure and record the durometer hardness of the packer rubber. Install RCD on stripping machine. Connect opening and closing lines to RCD. Connect line from the high-pressure test pump to the stump or RCD side outlet.

b) Connect an accumulator (5 gallon minimum) to the wellbore (stump) and precharge to 75 % of the wellbore pressure to be used during the tests. The closing line and wellbore line each shall be at least equipped with a pressure transducer. Connect all pressure transducers to a data acquisition system to provide a permanent record.

c) If a single packer element is used for range of drill pipe (mandrel) sizes, the tests shall be performed on minimum OD and maximum OD mandrels with applicable tool joint geometries. All packer element sizes shall be tested for corresponding drill pipe size.

d) This test validates the stripping pressure rating of a specific model RCD packer element while stripping a minimum of 400 tool joints through the closed packing unit without leaking fluid in excess of 1 gal/min while stripping at the manufacturer's specified stripping pressure rating at a minimum of 2 tool joints per minute. Test system should maintain the wellbore pressure within –10 % of rated stripping pressure during the stripping operation. Leakage at end of test should be zero with the element sealing on the mandrel body at stripping pressure rating. Documentation shall include:

   1) wellbore pressure and temperature used during the test;

   2) wellbore fluid used during the test;

   3) mandrel size and length and tool joint geometry (refer to Table 2);

   4) record of reciprocating speed;

   5) model part numbers of packing element;

   6) wellbore fluid pulled through volume measured during the test;

   7) record of the temperature conditions during the test (ambient and surface temperature of mandrel).

B.5.5 Stripping Life Test

The following procedure is used for conducting stripping life tests on all RCD elements and can be continuation of Stripping Pressure Rating Test.

a) Measure and record the durometer hardness of the packer rubber. Install RCD on stripping machine. Connect opening and closing lines to RCD. Connect line from the high-pressure test pump to the stump or RCD side outlet.

b) Connect an accumulator (5 gallon minimum) to the wellbore (stump) and precharge to 75 % of the wellbore pressure to be used during the tests. The closing line and wellbore line each shall be at least equipped with a pressure transducer. Connect all pressure transducers to a data acquisition system to provide a permanent record.

c) If a single packer element is used for range of drill pipe (mandrel) sizes, the tests shall be performed on minimum OD and maximum OD mandrels with applicable tool joint geometries. All packer element sizes shall be tested for corresponding drill pipe size.

d) For active-RCD close the RCD with the manufacturer's recommended closing pressure. Apply manufacturer's recommended wellbore pressure and reduce the closing pressure until the RCD leak rate is less than 1 gpm (to wet the test mandrel wall).

e) Reciprocate the test mandrel at speed of approximately 1 ft/sec, 5 ft in each direction and at a minimum of 2 tool joints per minute. Wellbore pressure should vary no more than –10 % during the stripping operation. Increase the closing pressure, as needed, to maintain a seal. Continue testing at the manufacturer's recommended closing pressure, for 1000 tool joints or until a visible leak develops (fluid leaking in excess of 1 gpm). Observe for leak at end of stroke with pipe stationary.

f) Document wear on all packer elastomers.

g) Record stripping friction forces, if applicable.

B.5.6 Dynamic Pressure Rating Test

If the design of an RCD is such that it functionally includes more than one bearing assembly while operating, then each bearing assembly must be tested independently to validate the dynamic pressure rating of the RCD. The following procedure is used for conducting dynamic pressure rating tests on RCDs.

a) Install the RCD (with either an active or passive element and associated bearing installed) on the test stump. Connect opening and closing lines (if appropriate) to the RCD. Connect line from the high-pressure test pump to the stump or the RCD side outlet.

b) Reinstall the drill pipe test mandrel in the RCD. Fill the RCD body to just above the top of the packer element with water.

c) Connect the cooling and lubrication system to the RCD if the design of the RCD functionally includes these systems while operating.

d) Apply manufacturer's recommended closing pressure (if appropriate).

e) Measure and establish the baseline rotating torque. Rotating torque must be within the manufacturers written specifications.

f) Apply increasing wellbore pressure until wellbore pressure equals the manufacturers dynamic pressure rating of the RCD and hold for 3 min.

g) Start rotating the drill pipe test mandrel in the RCD, increasing rotary speed until it equals the maximum RPM associated with manufacturers dynamic pressure rating of the RCD. Continue rotation at the maximum RPM and wellbore pressure associated with manufacturers dynamic pressure rating of the RCD for 100 hours. Measure and record coolant temperature in and out of bearing, if applicable. Measure and record the volume of lubricant lost during the test. This is the minimum requirement for certification.

h) Stop rotation. Increase wellbore pressure until it equals the static pressure rating of the RCD and hold for 3 min. Bleed off wellbore pressure to zero.

i) Measure and document rotating torque. Rotating torque must be within the manufacturers written specifications.

j) Repeat items f through i on the bearing until any of the following occurs:

— A leak develops in the bearing seals allowing wellbore or hydraulic or lubrication pressure to bypass the seals.

— Rotating torque tests falls outside the manufacturers written specifications.

— Slippage between the test mandrel and the packing element occurs; and mandrel rotation is at the maximum RPM associated with manufacturers recommended dynamic pressure rating of the RCD and the wellbore pressure equals the manufacturers recommended dynamic pressure rating static of the RCD and the RCD closing pressure (if applicable) equals the manufacturers recommended closing pressure.

— Total 200 hours rotation at the maximum RPM and wellbore pressure associated with manufacturer’s dynamic pressure rating of the RCD.

Annex C
(informative)

Design Temperature Verification Test Procedures Used to Verify the Temperature Range of Non-Metallic Seals and Molded Assemblies

C.1 General

This annex provides recommended guidelines for design temperature verification of API 16RCD equipment

C.2 Test Parameters

C.2.1 Pressures

Low- and high-pressure tests are required at each temperature. The low-pressure test shall be at 50 psi to 100 psi. The high-pressure test shall be at the static pressure rating of the equipment.

C.2.2 Hold Period

The hold period shall begin when the specified pressure and temperature have been reached and have stabilized. The minimum hold time shall be as specified.

C.2.3 Monitoring Techniques

C.2.3.1 General

All tests shall be done in conjunction with a suitable data acquisition system for both the pressure and the temperature. The data acquisition shall be in accordance with the manufacturer's written specification. The information shall be identified, dated, and signed/verified by the tester and witnesses as applicable.

C.2.3.2 Pressure Measurement

All devices used to measure or monitor pressure shall be in accordance with 7.2.

C.2.3.3 Temperature Measurement

The RCD shall have a minimum of one thermocouple. The thermocouple shall be within 0.5 in. of the through-bore, and shall be located as close as is practical to the component being tested. All devices used to measure or monitor temperature shall be calibrated in accordance with the manufacturer's written specification.

C.2.4 Records

Measurements on the non-metallic seals and/or molded sealing assemblies shall be made and recorded prior to installing them in the RCD.

C.3 Procedure for High-temperature Testing of RCDs

C.3.1 High-temperature Tests on Active-type RCDs

The following procedure is used for conducting high-temperature tests on active-type RCDs.

a) Install the RCD on the test apparatus as follows.

1) Connect the hydraulic operating lines.

2) Connect the lines from the high-pressure test pump and the high-temperature heating device to the test apparatus or to suitable connections on the RCD.

b) The closing pressure and wellbore pressure lines shall each be equipped, as a minimum, with pressure transducers. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install the non-metallic seals and/or molded sealing assembly in the RCD and secure them in accordance with the manufacturer's written procedure.

d) Install test mandrel in the RCD. The test is conducted on a drill pipe mandrel of the minimum diameter for each sealing element as specified by the manufacturer.

e) Open the RCD and begin heating the test fluid until the test temperature is reached and has stabilized.

f) Close the RCD using the manufacturer's recommended operating pressure.

g) Apply pressure equal to the static pressure rating of the RCD and hold for a minimum of 60 min. after pressure stabilization.

h) Decrease the wellbore test pressure to zero.

i) Open the RCD.

j) Document the results of the tests.

C.3.2 High-temperature Tests on Passive-type RCDs

The following procedure is used for conducting high-temperature tests on passive-type RCDs.

a) Install the RCD housing on the test apparatus and connect the lines from the high-pressure test pump and the high-temperature heating device to the test apparatus or to suitable connections on the RCD. To apply heat evenly to the assembly being tested, the test fluid should be circulated across the assembly.

b) The wellbore pressure lines shall be equipped, as a minimum, with pressure transducers. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install the non-metallic seals and/or molded sealing assembly in the RCD and secure them in accordance with the manufacturer's written procedure.

d) Install test mandrel in the RCD. The test is conducted on a drill pipe mandrel of the minimum diameter for each sealing element as specified by the manufacturer.

e) Begin heating the test fluid until the test temperature is reached and has stabilized.

f) Apply pressure equal to the static pressure rating of the RCD and hold for a minimum of 60 min. after pressure stabilization.

g) Decrease the wellbore test pressure to zero.

h) Open the RCD.

i) Document the results of the tests.

C.4 Procedure for Low-temperature Cycle Testing RCD

C.4.1 Low-temperature Tests on Active-type RCDs

The following procedure is used for conducting low-temperature tests on active-type RCDs.

a) Install the RCD on the test apparatus as follows.

   1) Connect the hydraulic operating lines.

   2) Connect the lines from the high-pressure test pump to the test apparatus or to a suitable connection on the RCD.

b) The closing pressure and wellbore pressure lines shall each be equipped, as a minimum, with pressure transducers. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install the non-metallic seals and/or molded sealing assembly in the RCD and secure them in accordance with the manufacturer's written procedure.

d) Install test mandrel in the RCD. The test is conducted on a drill pipe mandrel of the minimum diameter for each sealing element as specified by the manufacturer.

e) Open the RCD and begin the cooling cycle. Continue cooling until the test temperature is reached and has stabilized.

f) Close and open the RCD 7 times using the manufacturer's recommended operating pressure.

g) Close the RCD and apply 50 psi to 100 psi wellbore pressure and hold for a minimum of 3 min. after pressure stabilization.

   1) Decrease the wellbore test pressure to zero.

   2) Apply pressure equal to the static pressure rating of the RCD and hold for a minimum of 3 min. after pressure stabilization.

   3) Decrease the wellbore test pressure to zero.

   4) Open the RCD.

h) Repeat items f and g twice more for a total of 21 close/open cycles and 3 pressure test cycles.

i) Document the results of the tests.

C.4.2 Low-temperature Tests on Passive-type RCDs

The following procedure is used for conducting low-temperature tests on passive-type RCDs.

a) Install the RCD housing on the test apparatus and connect the lines from the high-pressure test pump and the cooling system to the test apparatus or to suitable connections on the RCD.

b) The wellbore pressure lines shall be equipped, as a minimum, with pressure transducers. All transducers shall be connected to a data acquisition system to provide a permanent record.

c) Install the non-metallic seals and/or molded sealing assembly in the RCD and secure them in accordance with the manufacturer's written procedure.

d) Install test mandrel in the RCD. The test is conducted on a tapered mandrel designed to model the minimum drill pipe diameter and the maximum tool joint OD for each sealing element as specified by the manufacturer.

e) Begin the cooling cycle. Continue cooling until the test temperature is reached and has stabilized.

f) Stroke the test mandrel through the RCD seven times ensuring maximum stretch and contraction of the RCD packer on each stroke.

g) Position the drill pipe portion of the test mandrel in the RCD packer and apply 50 psi to 100 psi wellbore pressure and hold for a minimum of 3 min. after pressure stabilization.

   1) Decrease the wellbore test pressure to zero.

   2) Apply pressure equal to the static pressure rating of the RCD and hold for a minimum of 3 min. after pressure stabilization.

   3) Decrease the wellbore test pressure to zero.

h) Repeat items f and g twice more for a total of 21 stretch/contract cycles and 3 pressure test cycles.

i) Document the results of the tests.

C.5 High/Low-temperature Cycle Testing of Hybrid RCDs

Each packer element in the hybrid design must be tested to this specification independently.

Procedures for testing of active and passive components shall conform to C.3 and C.4, respectively.

Annex D
(informative)

Purchasing Guidelines for Rotating Control Devices

D.1 General

This annex provides recommended guidelines for inquiry and purchase of API 16RCD equipment. The test procedures in Annex B and Annex C describe a minimum standard of testing RCDs. In special circumstances, fit for purpose testing that is tailored to a specific set of conditions may be used in addition to these tests. This fit for purpose testing can be conducted on the individual equipment to be used. Only the particular components tested for the individual application shall be deemed fit for that purpose and the test results will not apply to other equipment of the same make and model.

D.2 Size Designation

The size designation consists of the vertical bore through the body, the bore through the bearing and the size of top, outlet and bottom flanges.

D.3 Service Conditions

D.3.1 Body Pressure Rating

The body pressure rating is determined by the lowest pressure rating of all integral end or outlet connections.

D.3.2 Temperature Rating

D.3.2.1 General

Minimum temperature is the lowest ambient temperature to which the equipment may be subjected. Maximum temperature is the highest temperature of the fluid which may flow through the equipment.

D.3.2.2 Metallic Materials

Metallic parts will be designed to operate in 1 of 3 temperature ratings, which should be designated by the purchaser. These ratings can be found in Table 1.

D.3.2.3 Wellbore Elastomeric Materials

The purchaser should provide the temperature range for which wellbore elastomeric materials must operate. These ratings can be found in 8.3.4.3.

D.3.2.4 All Other Elastomeric Seals

The purchaser should provide the temperature range for which all other elastomeric materials must operate.

D.4 Outlet Connections

The purchaser should determine the number, location, size, pressure, and temperature ratings for all outlet connections.

D.5 Equipment Details/Data Book

Supply of a data book shall require a request by the purchaser and shall contain the following information:

a) purchase order number/sales order number;

b) product identification, type, part number, serial number;

c) date of completion and inspection;

d) assembly drawings, actual overall package dimensions, pressure rating, end connection/outlet description, weight, center of gravity, material where used list;

e) manufacturer's statement of compliance to current edition of API 16RCD;

f) material certificates;

g) welding procedure qualification;

h) NDE reports;

i) pressure test reports.

Annex E
(informative)

Failure Reporting

E.1 User Recommendation

The operator of RCDs manufactured to this specification shall provide a written report to the equipment manufacturer of any malfunction or failure which occurs. This report shall include as much information as possible as to the operating conditions that existed at the time of the malfunction or failure, and any operating history of the RCDs leading up to the malfunction or failure (e.g. field repair, modifications made to the RCDs, etc.).

E.2 Manufacturer's Recommendation

E.2.1 Manufacturer's Internal Requirements

All significant problems experienced with RCDs furnished to this specification noted during its manufacture, testing, or use shall be formally communicated to the individual or group within the manufacturer's organization responsible for the design and specification documents.

The manufacturer shall have a written procedure that describes forms and procedures for making this type of communication, and the manufacturer shall provide written records of progressive design, material changes, or other corrective actions taken for each model and size of RCDs.

E.2.2 Manufacturer's External Recommendations

All significant problems experienced with RCDs furnished to this specification should be reported in writing to each and every operator of the RCDs within 6 weeks after the occurrence. Design changes resulting from a malfunction or failure history of RCDs manufactured to this specification shall be communicated within 30 days after the design change by the manufacturer to each and every operator using the model or size RCDs having the malfunctions or failures, and all models of other RCDs that could have similar potential problems.

Annex F
(informative)

Metric Conversions and Fraction-to-Decimal Equivalents

English units are in all cases preferential (except for test coupons, which are 10 mm × 10 mm) and shall be the standard in this specification. Conversion factors are given in Table F.1. These factors are taken from API Publication 2564. Fraction-to-decimal conversions are provided in Table F.2.

Table F.1—Conversion Factors

Length
1 inch (in.) = 25.4 millimeters (mm), exactly
Pressure
1 pound per square inch (psi) = 0.06894757 Bar
Strength or Stress
1 pound per square inch (psi) = 0.006894757 Megapascals (mPa)
Impact Energy
1 foot-pound (ft-lb) = 1.355818 Joules (J)
Torque
1 foot-pound (ft-lb) = 1.355818 newton-meters (N-m)
Temperature
To convert degrees Fahrenheit (F) to degrees Celsius (C): °C = $^{5}/_{9}$ (°F – 32)
Mass
1 pound-mass (lbm) = 0.4535924 kilograms (kg)
Force
1 pound-force = 4.44823 newton (N)

Table F.2—Fraction-to-Decimal Conversion Chart

4ths	8ths	16ths	32nds	64ths	To 3 places	To 2 places
				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

4ths	8ths	16ths	32nds	64ths	To 3 places	To 2 places
				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

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[12] ASTM A453, *Specification for Bolting Materials, High Temperature, 50 to 120 ksi Yield Strength, with Expansion Coefficients Comparable to Austenitic Steels*

[13] ASTM D395, *Standard Test Methods for Rubber Property—Compression Set*

[14] ASTM D412, *Test Methods for Vulcanized Rubber, Thermoplastic Rubbers and Thermoplastic Elastomers*

[15] ASTM D471, *Standard Test Methods for Rubber Property—Effect of Liquids*

[16] ASTM D475, *Specification for Pure Para Red Toner Pigment*

[17] ASTM D569, *Method for Measuring the Flow Properties of Thermoplastic Molding Materials*

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3 American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, New York 10036, www.ansi.org.
4 ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.
5 American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228, www.asnt.org.

[20] ASTM D1415, *Test Method for Rubber Property-International Hardness*

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[23] ASTM E10, *Test Method for Brinell Hardness of Metallic Materials*

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[32] MIL-STD [6], MIL-STD-120, *Gage Inspection*

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[6] U.S. Department of Defense, Document Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, Pennsylvania 19111-5094, http://assist.daps.dla.mil.

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