Rotating Control Devices

API SPECIFICATION 16RCD
THIRD EDITION, XXXX 202X

API MONOGRAM PROGRAM EFFECTIVE DATE: XXXX

AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Users of this document should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

The verbal forms used to express the provisions in this document are as follows.

— Shall: As used in a standard, “shall” denotes a minimum requirement to conform to the standard.

— Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required to conform to the standard.

— May: As used in a standard, “may” denotes a course of action permissible within the limits of a standard.

— Can: As used in a standard, “can” denotes a statement of possibility or capability.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, Suite 1100, Washington, DC 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 200 Massachusetts Avenue, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, Suite 1100, Washington, DC 20001, standards@api.org.

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, testing 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.

1.2 Applications

1.2.1 Equipment

An RCD is considered a complete system when comprised of operationally interchangeable major 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 RCD System, Passive RCD System, and Hybrid RCD System (see Figure 1, Figure 2, and Figure 3) illustrate a surface BOP stack-up with each type of RCD installed);

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

c) RCD packing elements (active and passive types);

d) RCD housing including clamps or locking mechanisms.

1.2.2 Interchangeability

A complete RCD is comprised of a core component (i.e., body) and interchangeable, operationally replaceable subcomponents (i.e., sealing assembly) that comply with this specification.

NOTE At the discretion of the OEM, a single RCD body may be utilized with different sealing assembly(s) having various size designations and/or service conditions.

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.

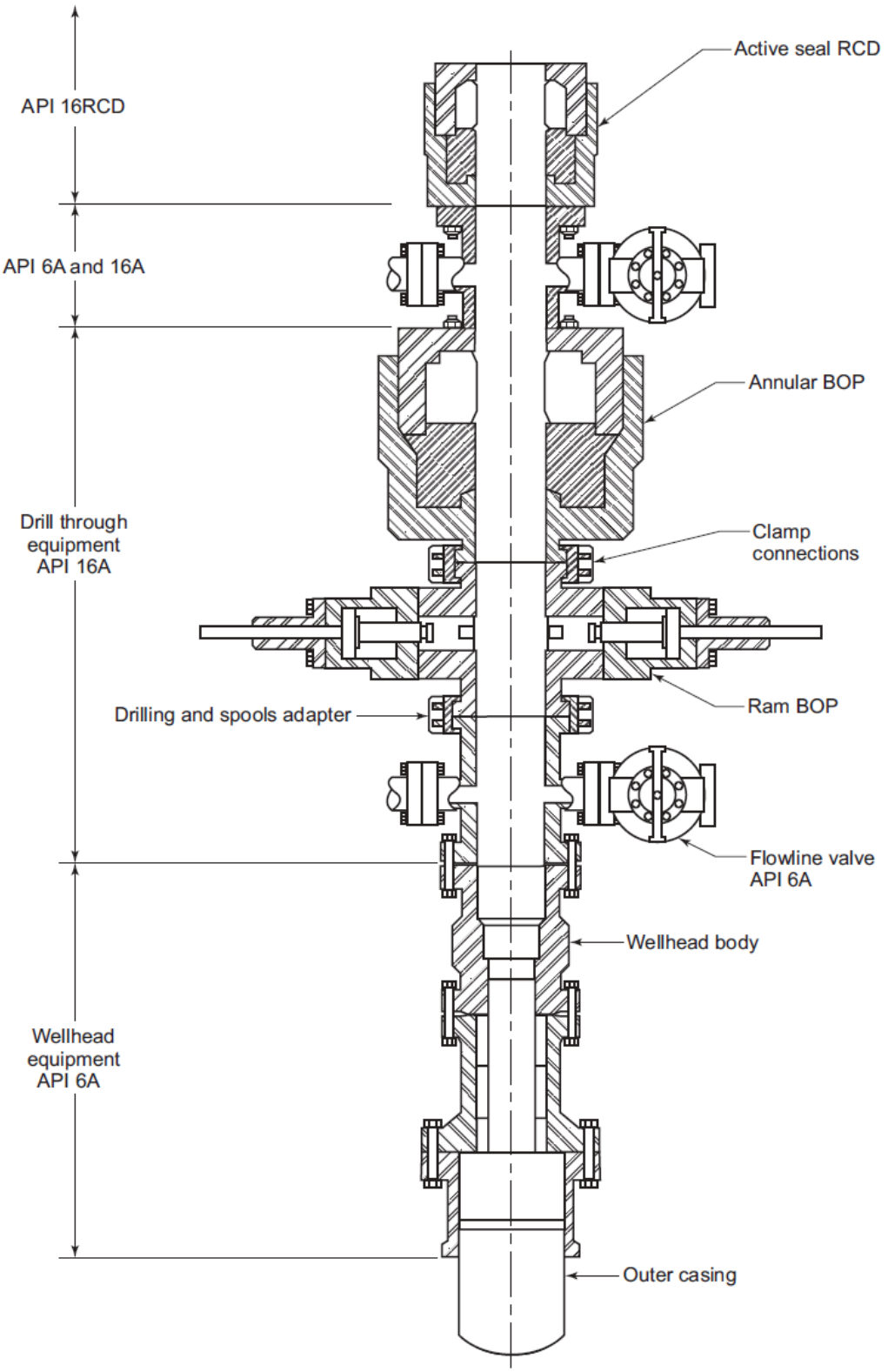


Figure 1—Typical Surface Stack illustrating an Active Rotating Control Device System

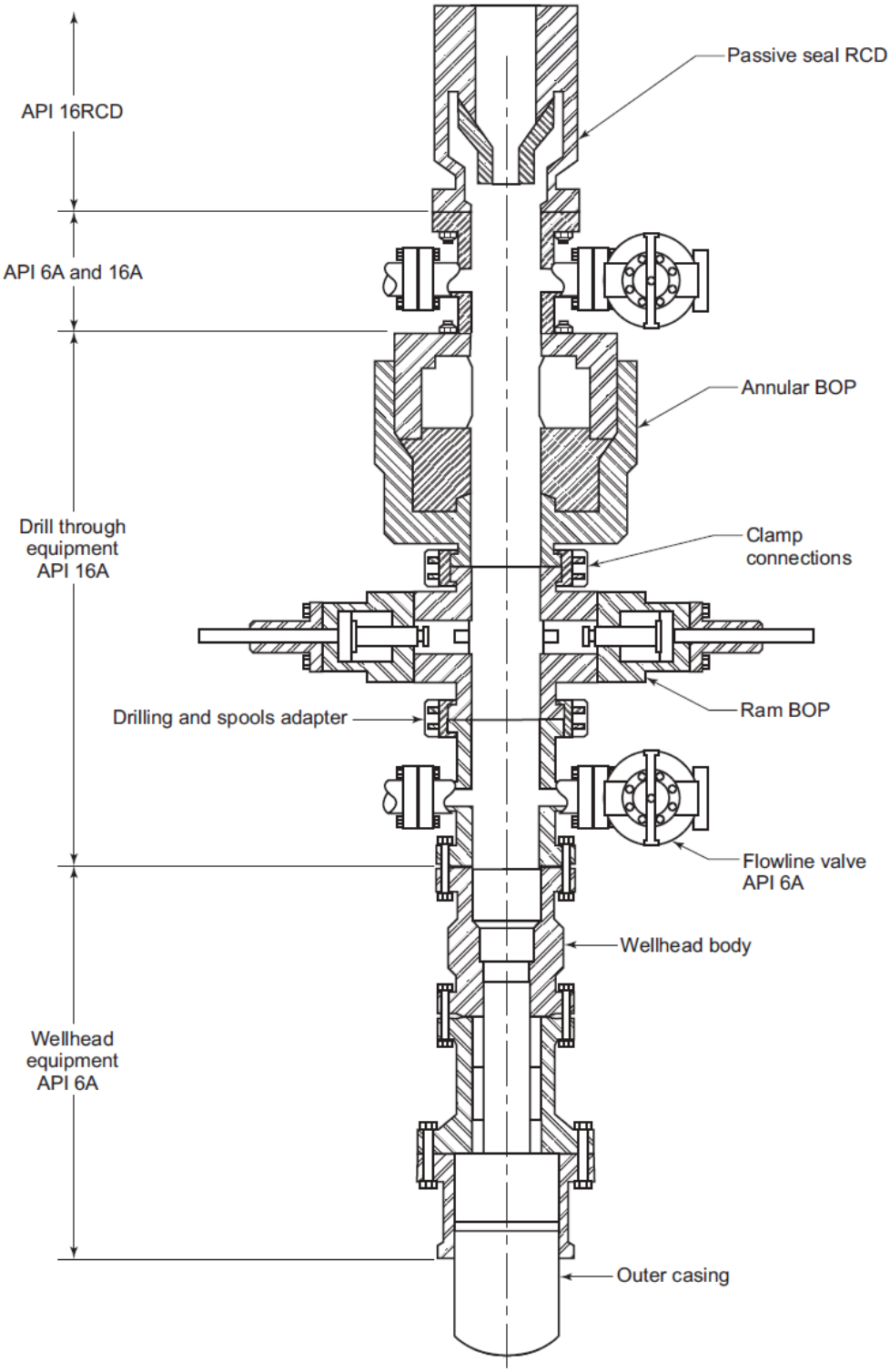


Figure 2—Typical Surface Stack illustrating a Passive Rotating Control Device System

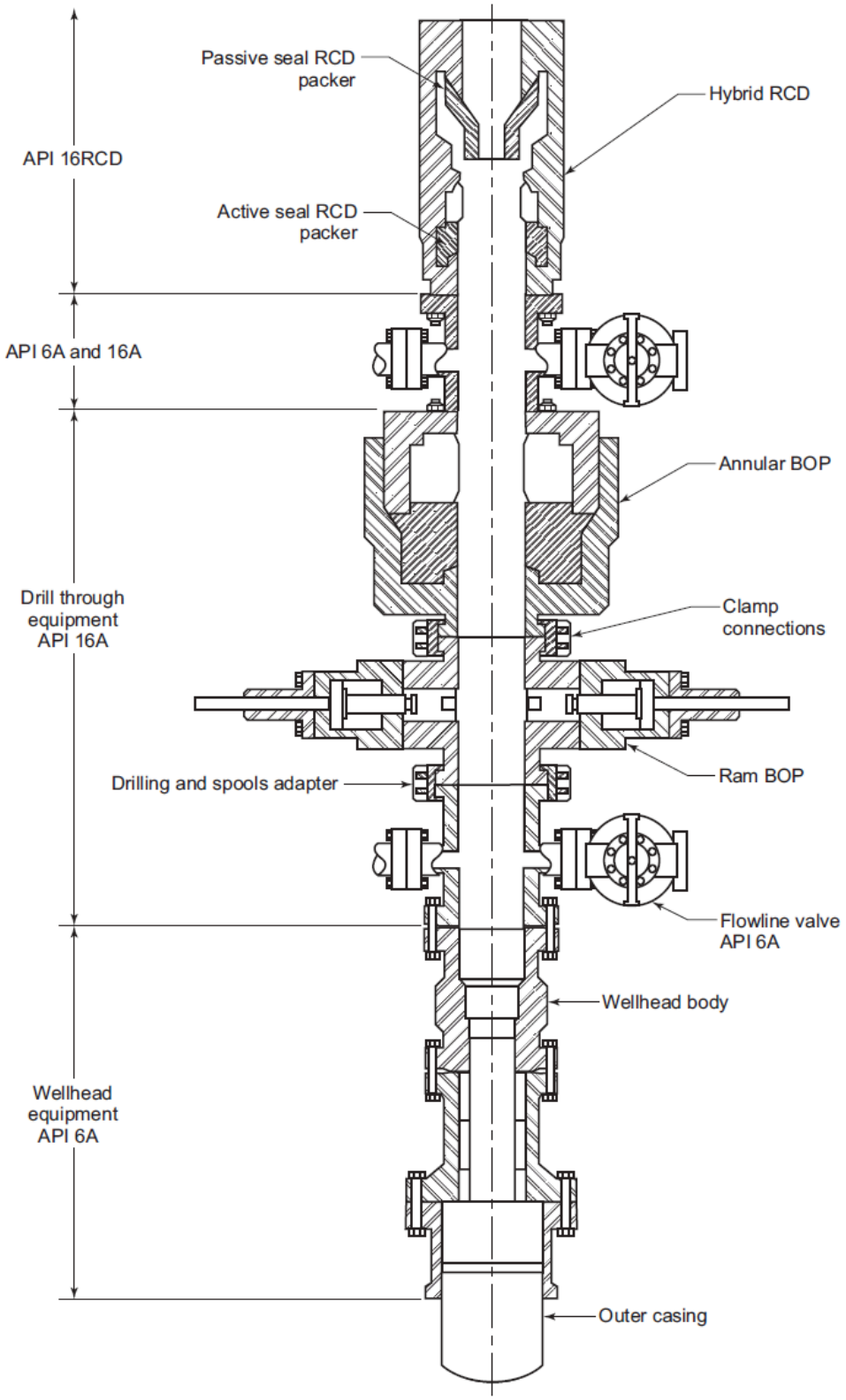


Figure 3—Typical Surface Stack illustrating a Hybrid Rotating Control Device System

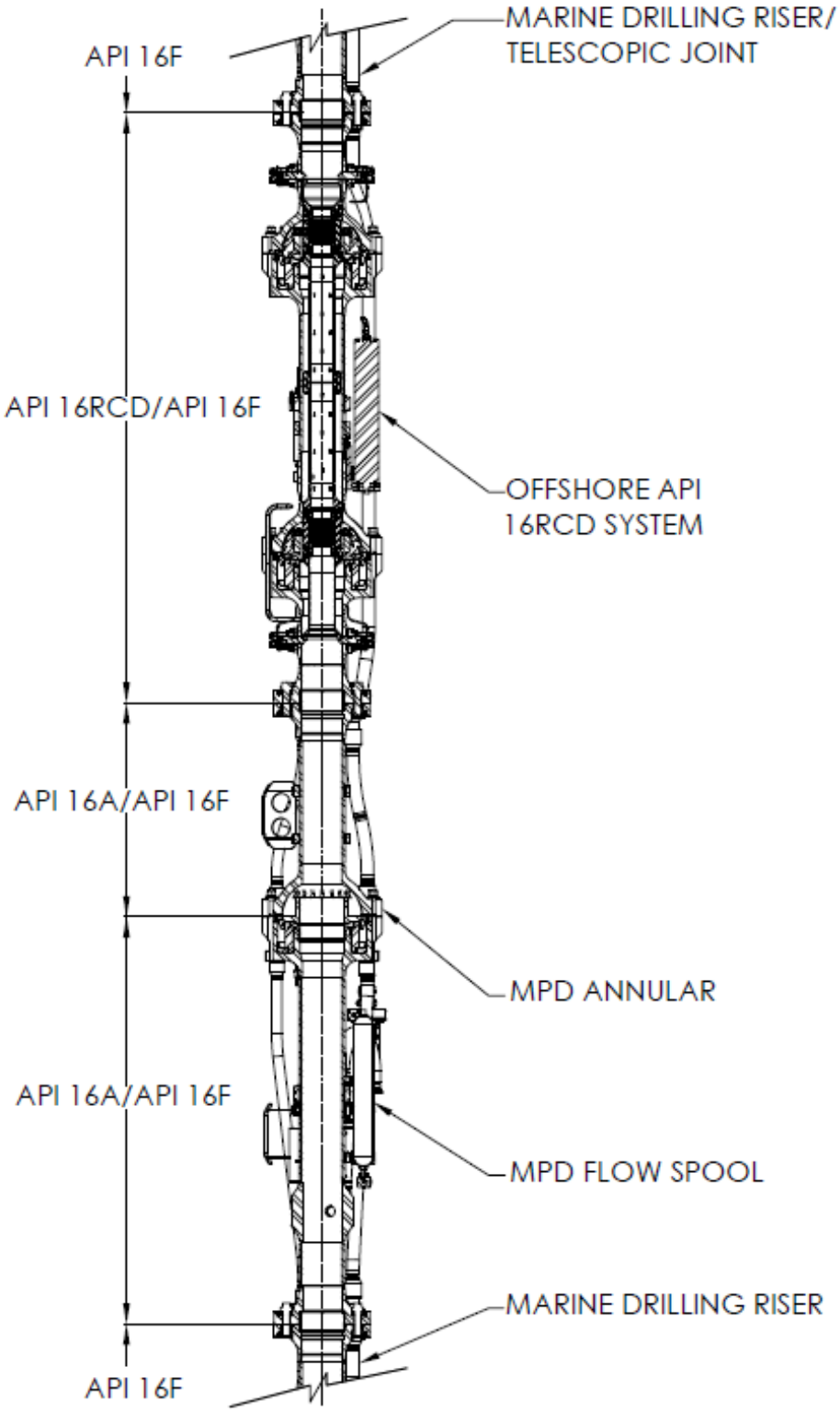


Figure 4—Offshore RCD System Installed Below the Tension Ring and above the Subsea BOP

2 Normative References

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

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

API Specification 16A, *Specification for Drill Through Equipment*

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

NACE[1] MR0175/ISO[2] 15156 (all parts), *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 force 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.

3.1.4
bolting
All threaded fasteners, including studs, tap-end studs, double-ended studs, headed bolts, cap screws, screws, and nuts.

3.1.5
bore protector
Replacement for the seals or packing elements for protection of the inner bore of RCD, to be installed then pressure control is not required.

[1] NACE International, 1440 South Creek Drive, Houston, Texas 77084-4906, www.nace.org.

[2] International Organization for Standardization, Chemin de Blandonnet 8, CP 401 - 1214 Vernier, Geneva, Switzerland, www.iso.org.

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
calibration
Comparison and adjustment to a standard of known accuracy.

3.1.9
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.

3.1.10
cast lot
Material originating from a final melt.

NOTE 1 For remelted alloys, a cast lot is the raw material originating from a single remelted ingot.

NOTE 2 Cast Lot is sometimes referred to as a heat

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
closure bolting
Threaded fasteners used to assemble wellbore pressure-containing parts or end and outlet connections.

3.1.14
conformance
conform
Fulfillment of specified requirements in every detail.

3.1.15
corrosion resistant ring groove
Ring grooves lined with a corrosion-resistant weld overlay to improve service life.

3.1.16
blind connection
End or outlet connection with no center bore, used to completely close off a connection.

3.1.17
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.

3.1.18
date of manufacture
Date of manufacturer's final acceptance of finished equipment.

3.1.19
dynamic pressure rating
Maximum pressure rating while including rotation of the drill string at a given RPM.

3.1.20
end connection
Flanges (studded or open face), hub connections or other end connections which are used to join together equipment and are integral to the equipment.

3.1.21
equipment
Any single completed unit that can be used for its intended purpose without further processing or assembly.

3.1.22
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.

3.1.23
forging <noun>
A shaped metal part formed by the forging method.

3.1.24
forging <verb>
Plastically deforming metal, usually hot, into desired shapes with compressive force, with open or closed dies.

3.1.25
full penetration weld
A weld that extends throughout the complete wall section of the joined parts.

3.1.26
heat treatment
Alternate steps of controlled heating and cooling of materials for the purpose of changing physical or mechanical properties.

3.1.27
hub
Protruding rim with an external angled shoulder and a sealing mechanism used to join pressure-containing equipment.

3.1.28
hybrid RCD system
A rotating control device (RCD) that combines a passive RCD system with an active RCD system.

3.1.29
hydraulic operating chamber
Any internal or integral cavity of an RCD that is used to contain a hydraulic pressure.

3.1.30
hydraulic operating system rated working pressure
Maximum hydraulic pressure at which the equipment is designed to operate.

3.1.31
hydraulic operating system recommended operating pressure
Manufacturer's recommended operating pressure.

3.1.32
integral
Parts which are joined by the forging, casting, or welding process.

3.1.33
leakage
Visible passage of the pressurized fluid from the inside to the outside of the pressure containment area of the equipment being tested.

3.1.34
other end connection
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.

3.1.35
packing element
Sealing component(s) between the rotating control device and the drill string.

3.1.36
part
Individual piece used in the assembly of a single equipment unit.

3.1.37
Passive RCD System
RCD system wherein no external force is supplied to maintain the seal between the seal element and the drill pipe.

3.1.38
post-weld heat treatment
Any heat treatment after welding, including stress relief.

3.1.39
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.

3.1.40
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).

3.1.41
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.

3.1.42
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.

3.1.43
RCD housing clamp
Device used to fasten and lock mating RCD body components.

3.1.44
records
Retrievable information.

3.1.45
rotating control device
RCD
Drill-through equipment designed to allow the rotation of the drill string and containment of pressure using seals or packing elements that seal against the drill string (drill pipe, casing, etc.).

3.1.46
rotating speed rating
Maximum rotating speed specified at a given pressure for a specific pipe size as defined by the manufacturer.

3.1.47
sealing assembly
An interchangeable, operationally replaceable subcomponent of an RCD that, once inserted into the RCD body, provides primary pressure containment against the drill string (drill pipe, casing, etc.) while allowing for rotation.

NOTE The sealing assembly may include rotating or non-rotating components.

3.1.48
serialization
Assignment of a unique code to individual parts and/or pieces of equipment to maintain records.

3.1.49
Service Application Level
SAL
Operational service conditions to which RCDs would be exposed.

3.1.50
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.

3.1.51
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.

3.1.52
static pressure rating
Maximum design validation pressure of a complete RCD with a new element that the equipment is designed to control with no pipe movement.

3.1.53
stress relief
Controlled heating of material to a predetermined temperature for the purpose of reducing any residual stresses.

3.1.54
stripping
Adding or removing pipe from a pressured wellbore while controlling flow from the wellbore.

3.1.55
stripping pressure rating
Maximum pressure when reciprocating or stripping the drill string for a specific packing element.

3.1.56
studded connections
Connections in which thread-anchored studs are screwed into tapped holes.

3.1.57
volumetric nondestructive examination
Examination for internal material defects by radiography, acoustic emission, or ultrasonic testing.

3.1.58
weld
Remelted and metallurgically altered area where two parts are joined by melting a portion of each part by heating with an electric arc or flame source.

3.1.59
welding
Application of any one of a group of welding processes that applies heat energy sufficient to melt and join one or more pieces of metal through localized fusion and coalescence.

3.1.60
yield strength
Stress level measured at room temperature, expressed in pounds per square in. (kg/m^2) of loaded area, at which material plastically deforms and will not return to its original dimensions when the load is released.

NOTE 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.

CRA corrosion-resistant alloy

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

SAL Service Application Level

4 Design Requirements

4.1 Size Designation

4.1.1 API Designated Size

RCDs shall be identified by the following:

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

b) bore through body;

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

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

e) drift diameter with bore protector installed.

4.1.2 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.

4.2 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 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 (°C)
T–75	–75 to 250
T–20	–20 to 250
T–0	0 to 250

4.2.2.2 Wellbore Elastomeric Materials

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

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

4.2.2.3 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

Metallic materials that come in contact with well fluids shall meet the requirements of NACE MR0175/ISO 15156 for sour service.

4.3 Equipment-specific Design Requirements

4.3.1 Members Containing Wellbore Pressure

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

4.3.2 Sealing Assembly Latching Mechanism

4.3.2.1 Design Methods

The manufacturer shall document the load/capacity for the RCD clamp connection using the same format as used for API flanges in API 6AF2. The manufacturer shall state whether the limitation is in the stress level of the clamp or the RCD hub.

Note: This format relates pressure to allowable bending moment for various tensions.

4.3.3 End and Outlet Connections

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

4.3.4 Flanged End and Outlet Connections

4.3.4.1 General

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

The RCD bottom connection pressure rating shall be equal to or greater than the static pressure rating of the RCD.

The side outlet connection pressure rating shall be equal to or greater than the static pressure rating of the RCD. Type 6B and 6BX flange connections may be used as integral connections.

Type 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.

4.3.4.2 Design

4.3.4.2.1 Flange Connections

Type 6B and 6BX flange connections shall be designed for use in the combination of API size designation and pressure ratings in accordance with API 6A. Dimensions for ring grooves shall conform to API 6A. Corrosion resistant ring grooves shall conform to API 6A.

4.3.5 Studded End and Outlet Connections

The two types of studded end and outlet connections (Types 6B and 6BX) in this specification shall conform to API 6A. Types 6B and 6BX studded connections may be used as integral connections. Dimensions for ring grooves shall conform to API 6A. Corrosion resistant ring grooves shall conform to API 6A. Studded connection thread form and minimum depth shall be in accordance with API 6A

Design for studded end and outlet connections shall be in accordance API 6A.

4.3.6 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 (Types 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 ring grooves.

4.3.7 Other End Connections

4.3.7.1 General

This section provides requirements for other end connections (OECs) 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.

4.3.7.2 Design

4.3.7.2.1 Design Methods

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.

4.3.7.2.2 Size

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

4.3.7.2.3 Bore Dimensions

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

4.3.7.3 Materials

OEC materials shall meet the requirements of Section 5.

4.3.7.4 Testing

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

4.3.8 Blind Connections

4.3.8.1 Flanges

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

4.3.8.2 Hubs

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

4.3.8.3 OECs

The design and configuration of blind OECs shall conform to 4.3.7.2, 4.3.7.3, and 4.3.7.4.

4.3.9 Weld Neck Hubs

Non-API weld neck hubs are outside the scope of this specification.

4.3.10 Bolting

Closure bolting shall be designed in accordance with API 16A

Closure bolting requirements are not applicable to sealing assembly bolting.

Sealing assembly bolting and all other bolting not classified as closure shall be in accordance with manufacturer's specification.

4.3.11 Ring Gaskets

Gaskets used for equipment manufactured to this specification shall be in accordance with API 6A.

4.3.12 Test, Vent, Injection, and Gauge Connections

Test, vent injection, and gauge connections of flanges, hubs, and OECs shall be in accordance with API 6A.

4.3.13 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 Design Validation

4.4.1 General

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

Experimental confirmation of the design shall be documented and verified as required in 4.5.

4.4.2 RCDs

Tests of the operating characteristics for RCDs shall conform to 4.6.

4.4.3 RCD Packing Elements

Tests on RCD packing elements shall conform to 4.6.

Design temperature validation on RCD packing elements shall conform to 4.6.4.6.4.

4.4.4 Other End Connections

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

4.5 Documentation

4.5.1 Design Documentation

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

4.5.2 Design Review

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

4.5.3 Design Validation

Manufacturer written specifications for design validation shall include the following:

a) Design validation test procedures.

b) Measuring and test equipment, including calibration verification.

c) Traceability for the equipment subject to design validation.

d) Design validation test results.

4.5.4 Documentation Retention

Design documentation shall be retained for a minimum of 10 years after the last unit of that model, size, and static pressure rating is manufactured.

4.6 Operational Characteristics Tests

4.6.1 Requirements

Design validation shall be in accordance with Table 2. Additional validation procedures, including acceptance criteria, are given in Annex A for use if specified by the manufacturer or purchaser.

Table 2—RCD Test Requirements

Test Required	Passive RCD System		Active RCD System		Hybrid RCD System		
	Sealing Assembly	Packing Element	Sealing Assembly	Packing Element	Sealing Assembly [a]	Passive Packing Element	Active Packing Element
Static pressure rating test	Yes		Yes		Yes		
Dynamic pressure rating test	Yes [a]	No	Yes [a]		Yes [a]	No	Yes
Packing element access test	Yes [d]	No	Yes		Yes		
Stripping rating test	N/A	Yes	N/A	Yes	N/A	Yes	Yes
Stripping life test	N/A	Yes	N/A	Yes	N/A	Yes	Yes
Fatigue test	N/A	N/A	N/A	Yes	N/A	N/A	Yes [b]
Sealing characteristics test	N/A	N/A	N/A	Yes	N/A	N/A	Yes [b]
Low temperature validation test	Yes [c]		Yes [c]		Yes [c]		
High temperature validation test	Yes [c]		Yes [c]		Yes [c]		

[a] If the design of an RCD is such that it functionally includes more than one sealing assembly, then each sealing assembly shall be tested independently.

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

[c] For Temperature Class XX, temperature validation tests are not required

[d] A dimensionally equivalent test plug may be used in place of the sealing assembly.

4.6.2 Scaling

If scaling of size and static, dynamic, and stripping pressure is utilized, scaling shall conform to Table 3. The manufacturer shall document his technical justification.

Table 3—Acceptable Scaling Practices for Operational Characteristics Tests

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

Legend:

P_S Qualifies all API static pressure rating equal to and below that of the product tested. Exception: when packing elements 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. PST = 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.

[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 packing element is used for range of drill pipe (mandrel) sizes, the tests shall be performed on minimum OD and maximum OD mandrels with applicable API 5DP tool joint geometries. All packing element sizes shall be tested for corresponding drill pipe size.

4.6.3 Acceptance Criterion

With the exception of stripping tests, tests that verify pressure integrity shall have no visible leakage under the test pressure.

4.6.4 Procedure

4.6.4.1 General

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.

4.6.4.2 Static Pressure Rating Test

4.6.4.2.1 Purpose

This test shall validate the static pressure rating of the RCD.

4.6.4.2.2 Protocol

The test protocol shall be as follows.

1) Apply wellbore pressure to at least the static pressure rating of the RCD and hold for a minimum of 3 minutes after pressure stabilization.

2) During the entire hold period the monitored pressure shall not drop below the specified pressure.

4.6.4.2.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure;

b) test mandrel size;

c) model/part numbers of the assembly;

d) internal and external seals per manufacturer's written specification that will be exposed to wellbore pressure;

e) for sealing assemblies with multiple packing elements, each wellbore pressure containing housing shall be tested. This testing may done individually or as a complete assembly as required to insure all potential static wellbore containment is tested.

4.6.4.3 Dynamic Pressure Rating Test

4.6.4.3.1 Purpose

This test shall be performed to validate the dynamic pressure rating of the RCD to the manufacturer's stated wellbore pressure and corresponding rotational speed.

4.6.4.3.2 Protocol

The test protocol shall be as follows.

1) Install the RCD sealing assembly with packing element.

2) Install test mandrel.

3) Apply wellbore pressure and RPM at the specified dynamic pressure rating of the RCD.

4) Maintain stabilized test parameters throughout the test for a minimum of 100 hours.

4.6.4.3.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure;

b) rotating speed of the mandrel;

c) model/part numbers of the assembly, including all internal and external seals per manufacturer's written specification that will be exposed to wellbore pressure.

4.6.4.4 Packing Element Access Test

4.6.4.4.1 Purpose

This test shall be performed to determine the ability of the RCD housing clamp or locking mechanism to undergo repeated sealing assembly packing element changes without affecting operational characteristics.

4.6.4.4.2 Protocol

The test protocol shall be as follows.

1) Install and latch sealing assembly or test plug into RCD housing.

2) Unlatch and lift sealing assembly or test plug inside RCD housing.

3) Repeat steps a and b 20 times with a hydrostatic wellbore pressure test at the static pressure rating of the RCD after every 20th cycle. Hold time for pressure test shall be a minimum of 3 minutes after pressure stabilization.

4) Repeat procedure until 100 cycles and 5 hydrostatic pressure tests are completed.

4.6.4.4.3 Documentation

The following shall be included in the test documentation:

a) number of successful packing element cycles;

b) wellbore pressure;

c) model/part numbers of the assembly.

4.6.4.5 Stripping Pressure Rating Test

4.6.4.5.1 Purpose

This test shall be performed to validate the stripping pressure rating of a specific model RCD packing element while stripping a minimum of 400 tool joints at the manufacturers specified stripping pressure rating.

4.6.4.5.2 Protocol

The test protocol shall be as follows.

1) Close the RCD housing clamp or locking mechanism with packing element installed.

2) Install test mandrel.

3) Apply wellbore pressure at the specified stripping pressure rating of the RCD.

4) Reciprocate mandrel at a minimum of 2 tool joints per minute.

NOTE Reciprocation may be approximately 1 ft/sec (30 cm/sec) for 5 ft (1.5 m) in each direction.

5) Mandrel reciprocation distance shall be sufficient to pass the mandrel tool joint completely through the packing element.

6) Test system shall not permit the wellbore pressure to drop below 90 % of the specified stripping pressure for 400 tool joints.

7) There shall be no visible leakage with the element sealing on the mandrel body at stripping pressure rating with no mandrel movement.

4.6.4.5.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure and temperature used during the test;

b) wellbore fluid used during the test;

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

d) record of reciprocating speed;

e) record of 400 tool joints;

f) model/part Number of packing element

4.6.4.6 Stripping Life Test

4.6.4.6.1 Purpose

This test shall be performed to validate the stripping life of a specific model RCD packing element while stripping up to 1000 tool joints at the manufacturers specified stripping pressure rating. This test may be a continuation of the Stripping Pressure Rating Test.

4.6.4.6.2 Protocol

The test protocol shall be as follows.

1) Close the RCD housing clamp or locking mechanism with packing element installed.

2) Install test mandrel.

3) Apply wellbore pressure at the specified stripping pressure rating of the RCD.

4) Reciprocate mandrel at a minimum of 2 tool joints per minute.

NOTE Reciprocation may be approximately 1 ft/sec (30 cm/sec) for 5 ft (1.5 m) in each direction.

The mandrel reciprocation distance shall be sufficient to pass the mandrel tool joint completely through the packing element.

Test system shall not permit the wellbore pressure to drop below 90 % of the specified stripping pressure for up to 1000 tool joints.

There shall be no visible leakage with the element sealing on the mandrel body at stripping pressure rating with no mandrel movement.

4.6.4.6.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure and temperature used during the test;

b) wellbore fluid used during the test;

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

d) record of reciprocating speed;

e) record successful number of tool joints;

f) model/part number of packing element.

4.6.4.7 Fatigue Test

4.6.4.7.1 Purpose

This test shall be performed to determine the ability of an active-type RCD to maintain a 50 psi to 120 psi (345 kPa to 827 kPa) and rated static pressure seal throughout repeated closings and openings.

4.6.4.7.2 Protocol

The test protocol shall be as follows.

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

2) 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.

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

4) Close the RCD with the manufacturer’s recommended closing pressure.

5) Open the RCD with the manufacturer’s recommended opening pressure.

6) Repeat Items 4 and 5 seven times.

7) After the seventh cycle, apply 50 psi to 100 (345 kPa to 689 kPa) 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. This constitutes one pressure cycle.

8) Every 20th 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 packing element at 5-minute intervals until the packing element ID reaches the bore size of the RCD or until 30 min have elapsed. Record ID.

Repeat Items 4 through 7 until packing element leaks or until 364 close/open cycles (52 pressure cycles) have been completed, whichever is attained first.

4.6.4.7.3 Documentation

The following shall be included in the test documentation:

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;

c) wellbore pressure and temperature used during the test;

d) wellbore fluid used during the test;

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

f) model/part number of packing element.

4.6.4.8 Sealing Characteristics Test

4.6.4.8.1 Purpose

This test shall be performed to 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 packing element can be used with, as specified by the manufacturer. This test shall consist of four parts for the active packing element as follows:

a) Constant Wellbore Pressure Test -– this test shall determine the actual closing pressure required to maintain a wellbore pressure seal on the test mandrel.

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.

4.6.4.8.2 Protocol

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

1) 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.

2) 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.

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

4) Conduct constant wellbore pressure test as follows.

   i. Close RCD with manufacturer's recommended closing or differential pressure.

   ii. Apply 500 psi (3447 kPa) wellbore pressure.

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

   iv. Bleed off wellbore pressure and open the RCD.

   v. Repeat Items i through iv, increasing wellbore pressure in equal pressure increments until wellbore pressure equals the static pressure rating of the RCD.

5) Conduct constant closing pressure test as follows.

   i. Apply 500 psi (3447 kPa) closing or differential pressure.

   ii. 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.

   iii. Bleed off wellbore pressure and open RCD.

   iv. Repeat Items i through iii, increasing closing pressure in equal increments each time until closing pressure reaches the level recommended by the manufacturer.

4.6.4.8.3 Documentation

The following shall be included in the test document the wellbore pressure vs. closing pressure.

a) wellbore pressure and temperature used during the test;

b) wellbore fluid used during the test;

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

d) model/part number of packing element;

4.6.4.8.4 Temperature Test Parameters

4.6.4.8.4.1 General

Temperature tests shall be performed at the lower and upper limit of the temperature class from 8.3.4.3 for the component being tested.

For RCD sealing assemblies with multiple packing elements, the packing element temperature testing may be performed on a separate test fixture if the RCD assembly temperature testing is independently validated.

Temperature tests shall be conducted with test fluid in contact with non-metallic seals and molded sealing assemblies; temperature measurement shall be of the wellbore fluid. The test fluid used shall be specified by the manufacturer. The manufacturer shall document the procedure and results.

Hold periods shall start after pressure and temperature stabilization has occurred within the manufacturer's specified test range and the equipment with pressure monitoring device has been isolated from the pressure source. The time specified for hold times shall be a minimum.

4.6.4.8.4.2 Low Temperature Validation Test

4.6.4.8.4.2.1 Purpose

This procedure shall be performed to 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. The intent of this procedure is to verify the performance of these components during exposure to low temperatures.

4.6.4.8.4.2.2 Protocol

The test protocol shall be as follows.

1) Install the sealing assembly per the manufacturer's instructions on test fixture.

2) Cool the assembly until the test temperature of the wellbore fluid is held at or below the specified test temperature.

3) Mechanical cycling per RCD type.

   i. Passive style RCD: Stroke the test mandrel through the RCD seven (7) times ensuring maximum stretch and contraction of the RCD packing element on each stroke.

   ii. Active style RCD: Close and open the RCD seven (7) times using the manufacturer's recommended operating pressure.

   iii. Hybrid RCD System: Each packing element shall be tested independently as specified herein.

4) Low pressure test per RCD type:

   i. Passive style RCD: Position the drill pipe body of the test mandrel in the RCD packing element and apply between 50 psi and 100 psi (345 kPa to 689 kPa) wellbore pressure and hold for a minimum of 3 min.

   ii. Active style RCD: Close the RCD and apply between 50 psi and 100 psi (345 kPa to 689 kPa) wellbore pressure and hold for a minimum of 3 min.

   iii. Hybrid style RCD: Each packing element shall be tested independently as specified herein.

5) Decrease the wellbore test pressure to zero.

6) Apply pressure equal to or above the static pressure rating of the RCD and hold for a minimum of 3 min.

7) Decrease the wellbore test pressure to zero.

8) For Active or Hybrid RCD Systems, open the packing element.

9) Repeat items b through g twice more for a total of 21 mechanical cycles and 3 pressure test cycles.

4.6.4.8.4.2.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure;

b) wellbore fluid temperature;

c) wellbore fluid used during the test;

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

e) model/part number & serial number of packing element;

f) for Active and Hybrid RCD Systems, a record of wellbore pressure vs. closing pressure.

4.6.4.8.4.3 High Temperature Validation Testing

4.6.4.8.4.3.1 Purpose

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

4.6.4.8.4.3.2 Protocol

The test protocol shall be as follows.

1) Install the sealing assembly per the manufacturer's instructions on test fixture.

2) Install test mandrel

3) Heat the assembly until the test temperature of the wellbore fluid is held at or above the specified test temperature.

4) Apply pressure equal to or above the static pressure rating of the RCD and hold for a minimum of 60 min.

~~5)~~ During the entire hold period the monitored pressure shall not drop below the specified pressure.

4.6.4.8.4.3.3 Documentation

The following shall be included in the test documentation:

a) wellbore pressure;

b) wellbore fluid temperature;

c) wellbore fluid used during the test;

d) mandrel geometry (refer to Table 3);

e) model/part number and serial number of packing element;

f) for Active and Hybrid RCD Systems, Record of wellbore pressure vs. closing pressure.

4.7 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:

a) operation and installation instructions;

b) physical data;

c) packing element and seals information;

d) static pressure rating(s);

e) dynamic pressure rating(s);

f) stripping pressure rating(s);

g) maintenance and testing information;

h) disassembly and assembly information;

i) parts information;

j) hydraulic operating system rated working pressure (if applicable);

k) hydraulic operating system recommended operating pressure (if applicable);

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

5 Material Requirements

Material requirements shall conform to API 16A.

6 Welding Requirements

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

A data acquisition system shall be used on all hydrostatic tests and on hydraulic control system tests. The record shall identify the recording device and shall be dated and signed.

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

7.3 Quality Control Personnel Qualifications

Quality control requirements for personnel qualifications shall conform to 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.

7.5.2 Bolting

Quality control requirements for closure bolting shall conform to API 16A.

Quality control requirements for sealing assembly bolting and all other bolting not classified as closure shall be in accordance with manufacturer's specification.

7.5.3 Ring Gaskets

Quality control requirements for ring gaskets shall conform to the requirements of API 16A.

7.5.4 Non-metallic Sealing Materials and Molded Sealing Assemblies

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

7.5.5 Other Drill-through RCD Equipment

For other equipment not covered in this section, the quality control requirements shall be documented in the manufacturer's written specifications.

7.5.6 Assembled Equipment

7.5.6.1 Serialization

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

7.5.6.2 Traceability Record Report

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

7.6 Factory Acceptance Tests

7.6.1 General

Factory acceptance tests (FAT) by RCD type and major subcomponents shall be performed in accordance with Table 4.

Table 4—FAT Requirements

Test Type	Complete RCD Assembly [a]			Major Subcomponents		
	Passive RCD Sys.	Active RCD Sys.	Hybrid RCD Sys.	Sealing Assembly	RCD Body	Packing Element
Drift test	Yes	Yes	Yes	Yes	Yes	No
Hydrostatic body/shell test	Yes	Yes	Yes	No	Yes	No
Rotating torque test	Yes [b]	Yes [b]	Yes [b]	Yes	No	No
Hydraulic operating chamber test	Yes	Yes	Yes	Yes	Yes	No
Low pressure closed test	Yes [c]	Yes [c]	Yes [c]	Yes	No	No
High pressure closed test	Yes [c]	Yes [c]	Yes [c]	Yes	No	No

[a] The use of packing elements or test plug(s) in these FAT tests are at the discretion of the RCD manufacturer.

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

[c] 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.

7.6.2 Acceptance Criterion

With the exception of the Drift Test and Rotating Torque, tests that verify pressure integrity shall have no visible leakage under the test pressure.

7.6.3 Drift Test

7.6.3.1.1 Protocol

The drift test protocol shall be as follows.

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

2) Drift mandrel diameter shall be 0.020 in. to 0.030 in. (0.51 mm to 0.76 mm) less than the manufacturer's specified size designation of the bore of the bearing assembly and RCD body.

3) Drift mandrel gauge length shall be at least 2 in. (51 mm) longer than any cavity that intersects the bore, but not less than 12 in. (305 mm)

7.6.3.1.2 Acceptance Criterion

The drift mandrel shall pass through without being forced.

7.6.4 Hydrostatic Body Testing

7.6.4.1.1 General

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.

7.6.4.1.2 Protocol

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 times the static pressure rating.

The hydrostatic body test protocol shall be as follows.

1) Hold the initial test pressure for a minimum of 3 min.

2) Reduce the pressure to zero.

3) Hold the second test pressure for a minimum of 15 min.

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.

7.6.5 Rotating Torque Test

A rotating torque test shall be performed on the sealing assembly to confirm that the torque is within the manufacturer's specification.

This test is only required for RCDs with a rotating sealing assembly.

7.6.6 Hydraulic Operating Chamber Test

7.6.6.1.1 Protocol

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

7.6.7 Closed RCD Test

7.6.7.1 General

If the previous tests do not adequately address all pressure containing and load bearing members of an assembled unit, 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 closed RCD tests shall meet the requirements of 7.6.4.1.1.

b) The 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.

For multiple sealing assembly housings, each wellbore pressure containing housing shall be tested. This testing may done individually or as a complete assembly as required to insure all potential wellbore containment is tested.

7.6.7.2 Low-pressure Test

After stabilization, a pressure of 50 psi to 120 psi (345 kPa to 827 kPa) shall be applied and held below the closed RCD for a minimum of 10 minutes.

7.6.7.3 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 period of not less than 10 min after stabilization.

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 materials and equipment made to this specification conform to the specified requirements.

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 NACE MR0175/ISO 15156.

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 packing elements and seals for a minimum of 5 years.

Records required by this specification shall be signed and dated. Computer-stored records shall be identifiable to a specific individual.

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 through Section 7.

The following records shall be maintained for pressure-containing and pressure-controlling parts and components as described in 7.5.1.

a) Weld procedure qualification record (PQR).

b) Welder qualification record.

c) Material test records:

- chemical analysis;
- tensile tests (qualification test coupons (QTC));
- impact tests (QTC, as required);

- hardness tests (QTC).

d) Nondestructive examination (NDE) personnel qualification records.

e) NDE records:

- surface NDE records;
- full penetration weld fabrication;
- weld volumetric NDE records;
- repair weld NDE records.

f) Hardness test records.

g) Welding process records:

- welder identification;
- weld procedures;
- filler materials;
- post-weld heat treatments.

h) Heat treatment records:

- actual temperature;
- 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 cast lot traceability records for closure bolting.

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.

Purchasing guidelines included in Annex B may be utilized for enquiry or purchase of equipment covered by this specification.

7.7.4 Failure Reporting

Failure reporting shall be in accordance with Annex C.

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 and Table 5.

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

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.

Corrosion-resistant ring grooves shall be marked in accordance with API 6A.

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 packing elements 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.

Table 5—Marking Requirements and Locations

Marking [a]	RCD Assembly	RCD Body	Packing Element(s)	Sealing Assembly(s)
API 16RCD	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Nameplate and/or body
Manufacturer's name or mark	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Nameplate and/or body
Model or type designation	Nameplate and/or body	Nameplate and/or body		Nameplate and/or body
Serial number	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Nameplate and/or body
API size designation	Nameplate and/or connection OD [b]	Nameplate and/or connection OD [b]		
Body/shell pressure rating	Nameplate	Nameplate		Manufacturer's specification
Temperature rating	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Manufacturer's specification
Manufacturer's part number	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Nameplate and/or body
Date of manufacture	Nameplate and/or body	Nameplate and/or body	Manufacturer's specification	Nameplate and/or body
Hydraulic operating system rated working pressure	Nameplate and/or body (Active/hybrid RCD systems only)	Nameplate and/or body (Active/hybrid RCD systems only)		Manufacturer's specification
Hydraulic operating system recommended operating pressure	Nameplate and/or body (Active/hybrid RCD systems only)	Nameplate and/or body (Active/hybrid RCD systems only)		Manufacturer's specification
Hydraulic open and close ports	Manufacturer's specification (Active/hybrid RCD systems only)	Manufacturer's specification (Active/hybrid RCD systems only)		Manufacturer's specification
Ring groove designation	Connection OD [b,c,d]	Connection OD [b,c,d]		
Alpha-numeric codification system (8.3.4.1)			Manufacturer's specification	
Rotating Speed rating(s)	Manufacturer's specification			Manufacturer's specification
Service Application Level (refer to Annex A) [e]	Nameplate and/or body	Nameplate and/or body		Nameplate and/or body

[a] Components shall be marked in an easily accessible and readable area selected by the manufacturer.

[b] API and 16BX hub connections shall be marked on the neck of the connection, ½ in. (12.7 mm) maximum from the required length of the neck. (see API 16A)

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

[c] The number for corrosion-resistant ring grooves shall be followed with "CRA".

[e] Not required if the OEM chooses not to perform the Service Application Level testing in Annex A.

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 used for end and outlet connections 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 Packing Elements and Seals

8.3.4.1 Wellbore Non-metallic Components

RCD Packing Elements, 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 alpha-numeric codification system shall be in accordance with Table 6.

Table 6—Non-metallic Component Marking Code

Description	Digits
Compound hardness (durometer)	AA
Compound (refer to API 16A)	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.

Other wellbore non-metallic component identification shall be in accordance with the Manufacturer's written specifications.

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 in accordance with Table 7.

Table 7—Temperature Class

Lower Limit (First Digit) °F (°C)		Upper Limit (Second Digit) °F (°C)	
A	–15 (–26.1)	A	180 (82.2)
B	0 (–17.7)	B	200 (93.3)
C	10 (–12.2)	C	220 (104.4)
D	20 (–6.6)	D	250 (121.1)
E	30 (–1.1)	E	300 (148.9)
F	40 (–4.4)	F	350 (176.7)
G	Other	G	Other
X	[a]	X	[a]

[a] These components may have a temperature class of 40°F to 180°F (–4.4°C to 82.2°C) without performing temperature validation 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 (–1.1°C to 93.3°C).

8.3.5 End and Outlet Connections and OECs

End and Outlet Connections as well as OECs shall be marked in accordance with API 6A.

9 Storing and Shipping

9.1 Storing for Periods of Greater Than 30 Days

9.1.1 Draining after Testing

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 (52°C).

9.1.3 Connection Surface Protection

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.

9.2 Shipping

Equipment shall be shipped in accordance with the manufacturer's written procedures.

Annex A
(informative)

Service Application Testing

A.1 General

The purpose of this annex is to provide a standard testing methodology for the establishment of an operational envelope for RCDs in a prescribed environment. The contents of this annex shall be considered normative if an OEM elects to conduct the testing included herein.

Service Application Levels (SAL) relate to operational service conditions to which RCDs would be exposed.

The tests do not include all possible service scenarios, but strive to simulate drilling conditions more closely than those conditions included in 4.6.

The testing structure outlined in this section does not supersede the operational characteristics testing outlined in 4.6, it is meant to enhance it.

A.2 Service Application Levels

The Service Application Levels are defined as follows:

a) SAL 1 - Test is designed to simulate drilling with water-based mud (WBM);

b) SAL 2 - Test is designed to simulate drilling with oil-based mud (OBM);

c) SAL C – Any test conducted with parameters outside of SAL-1 & SAL-2.

A.3 Materials

A.3.1 Test Fluids

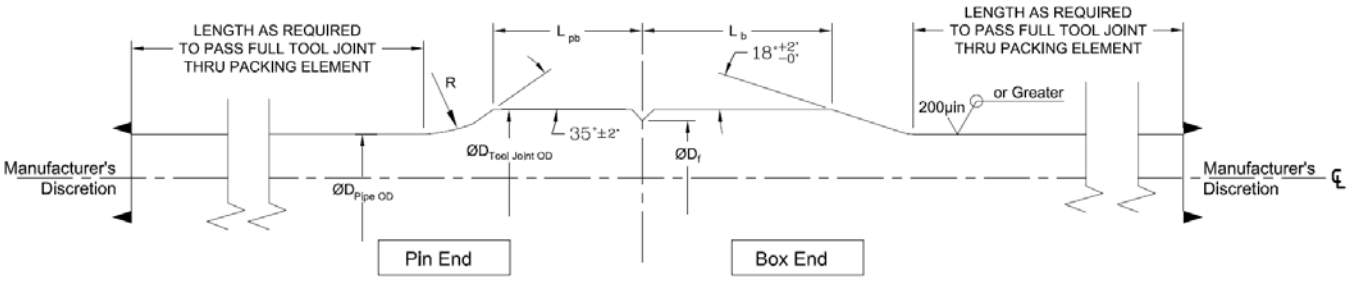
Test fluid shall be in accordance with Table A.1.

Table A.1—Fluid Specifications

SAL-1		SAL-2	
Item	**Amount** lb/bbl (kg/m^3)	**Item**	**Amount** lb/bbl (kg/m^3)
Water		Brine (CaCl2)	0.39 (1.1)
Xanthan gum	2.0 to 2.5 (5.7 to 7.1)	Organo clay	2.0 (5.7)
NaHCO	3.2 (9.1)	Rheology modifier	1.0 (2.9)
MgO	1.0 (2.9)	Synthetic base fluid (Olefina)	0.57 (1.6)
Anti-foam	0.3 (0.9)	Ca $(OH)_2$	5.0 (14.3)
Barite	As required to reach 12 ppg (17.3 kg/L)	Emulsifier	9.0 (8.3)
		Barite	As required to reach 12 ppg (17.3 kg/L)
NOTE For SAL-C, the test designer shall specify the fluid to be used.			

A.3.2 Test Mandrel

Test mandrel used for SAL testing shall be in accordance with Figure A.1.



NOTES:
a) For tool joint dimensions, refer to API 5DP Specification Annex C & Annex D
b) For SAL-C, Radius (R) and tool joint taper(s) shall be set by test designer(s).
c) For all SAL levels, API 5DP compliant drill pipe that meets the additional requirements specified herein may be used.

Figure A.1—SAL Test Mandrel

Scaling shall conform to 4.6.2.

A.4 Specification of Test Variables

Test variables shall be in accordance with Table A.2.

This section specifies the variables for each of the SALs.

Table A.2—Service Application Level - Test Variables

Test Variable	SAL-1 Value[a]	SAL-2 Value[a]	SAL-C Value[a]
Fluid type, f	12 ppg (1.44 SG) water-based mud[b,c]	12 ppg (1.44 SG) oil-based mud[b,c]	Set by test designer
Number of tool joints, n	400	400	Set by test designer This is typically the number of tool joints that can pass through the RCD over the stripping or snubbing distance.
Static pressure, P_S	1000 psi (6895 kPa) + 10 %	1000 psi (6895 kPa)	Set by test designer This is typically the planned connection back pressure, influx circulation pressure (MPD), or expected surface pressure during a flow test (UBD)
Stripping pressure, P_{st}	500 psi (3447 kPa) +/- 10 %	500 psi (3447 kPa)	Set by test designer
Drilling test pressure, P_d	500 psi (3447 kPa) + 10 %	500 psi (3447 kPa)	Set by test designer This is the expected drilling pressure during drilling (rotating and sliding).
Mandrel rotational speed, R	100 RPM	100 RPM	Set by test designer
Mandrel stroke speed during drill-ahead test, ROP	30 ft/hr (9.1 m/hr)	30 ft/hr (9.1 m/hr)	Set by test designer This is typically the expected rate of penetration for the planned open hole section
Mandrel stroke speed during stripping/snubbing, S	1 ft/sec (0.3 m/sec), at a minimum of 2 tool joints/min	1 ft/sec (0.3 m/sec), at a minimum of 2 tool joints/min	Set by test designer
Drilling test time, t_d	100 hours	100 hours	Set by test designer This is the shortest of the following a) planned duration to drill open hole section b) forecast RCD packing element life c) bit life d) MWD life
Wellbore temperature, T [d]	140°F (60°C)[e, f]	140°F (60°C)[e, f]	Set by test designer[g]
Upper tool joint angle, TJ_u	See Figure D.1 for test mandrel geometry	See Figure D.1 for test mandrel geometry	Set by test designer
Lower tool joint angle TJ_d	See Figure D.1 for test mandrel geometry	See Figure D.1 for test mandrel geometry	Set by test designer

[a] All variables are minimum unless otherwise specified.

[b] If the test facility does not permit the use of hydrocarbon-based fluids, the packing element shall be conditioned in oil based fluid at temperature according to G.7.1.

[c] If packing element is conditioned, then test fluid shall be water or an inert oil-based fluid.

[d] This is typically the expected return surface flow line temperature.

[e] Testing at 140°F for SAL-1 & SAL-2 does not supersede Section 4 temperature validation testing and wellbore elastomeric temperature rating.

[f] For return flow design temperature below 140°F, any requirement for Sal-1 or Sal-2 may be substituted with SAL-C testing provided that from the requirements of Table 2 are met or exceeded.

[g] Table 7 should be used to determine test temperature.

A.5 Packing Element Conditioning Guidelines

Fluid specification shall conform to Table A.1.

Fluid temperature shall be in accordance with Table A.2.

Packing element(s) shall be completely submerged in conditioning fluid at atmospheric pressure for the duration of the conditioning period.

Conditioning time shall be a minimum of 100 hours after fluid temperature stabilization.

Multiple packing elements of different compound types shall not be conditioned together.

A.6 Test Procedures

A.6.1 General

This testing shall be conducted using a completely assembled RCD.

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

A.6.2 Acceptance Criteria

A.6.2.1 Stripping Test

There shall be no visible leakage during the static pressure (P_s) test portions of the stripping test.

Test system shall not permit the wellbore pressure to drop below 90% of the specified stripping pressure (P_{st}).

A.6.2.2 Drilling Test

There shall be no visible leakage during static pressure (P_s) test portions of the drilling test.

Test system shall not permit the wellbore pressure to drop below 90% of the specified drilling pressure (P_d).

A.6.3 SAL Stripping Test

A.6.3.1 Purpose

The intent of this part of the test is to simulate the wear on the RCD while running in the hole (RIH) and pulling out of the hole (POOH) under pressure and temperature for a predetermined length, as well as conducting static pressure tests periodically to mimic various planned drilling operations.

A.6.3.2 Protocol

The test mandrel shall be inserted into the RCD/RCD packing element with the tool joint below the packing element and stabilize all variables to test conditions in accordance with Table A.2.

The test protocol shall be as follows.

1) Increase wellbore pressure to P_S and hold for 3 min with the packing element on the pipe body section of the test mandrel.

2) Set test pressure to the planned stripping pressure, P_{st}.

3) Set mandrel stroke speed to planned stripping speed, S.

4) Reciprocate the test mandrel such that the tool joint passes fully through the packing element(s).

5) Repeat for ½ (half) the planned number of tool joints, n.

6) Once n/2 tool joints have been passed through the element, stop reciprocation such that the packing element is sealing on the 'pipe body' portion of the mandrel and the tool joint is below the packing element.

7) Set wellbore pressure to P_S and hold for 3 min.

8) Set test pressure to planned stripping pressure P_{st} and resume mandrel reciprocation to n tool joints.

9) Once 'n' tool joints have passed through the packing element, stop reciprocation such that the packing element is sealing on the pipe body section of the mandrel and the tool joint is below the packing element.

10) Set wellbore pressure to P_S and hold for 3 min.

11) End test.

A.6.3.3 Documentation

Documentation shall include a record of the following:

Test variables from Table A.2

Mandrel geometry

Model and serial number of all tested RCD components

Packing element type and conditioning data (if applicable)

Summary of Test results

A.6.4 Drilling Test

A.6.4.1 Purpose

The intent of this part of the test is to simulate wear on the RCD while drilling under pressure and temperature for a predetermined time. This test will combine pipe rotation and reciprocation, as well as conducting static pressure tests periodically. The drilling test also includes a low-pressure test to demonstrate the sealing capability at low pressures with a worn/used packing element.

A.6.4.2 Protocol

The test protocol shall be as follows.

1) The test mandrel shall be inserted into the RCD/RCD packing element with the tool joint below the packing element and stabilize all variables to test conditions in accordance with Table A.2.

2) Increase wellbore pressure to (P_s) and hold for 3 min on the pipe body section of the test mandrel.

3) Set test pressure to the planned drilling pressure (P_d) to the RCD.

4) Rotate at speed (R) continuously for one quarter (1/4) of the planned test duration (td). While rotating, reciprocate tool joint fully through the packing element(s) at (ROP) or greater speed and repeat for a minimum of 25 TJ.

   For test facilities that have the ability to reciprocate as slow as (ROP), the tool joint portion of the test mandrel must be in contact with the packing element for a proper ratio of both time and reciprocation length of the drill pipe range qualified. The reciprocation speed should be a minimum of (ROP) on pipe body and maintain an average (ROP) speed when a TJ is passing through the packing elements.

5) At ¼ (td), stop rotation and reciprocation of the test mandrel such that the packing element is sealing on the pipe body portion of the mandrel and the tool joint is below the packing element.

6) Set wellbore pressure to P_s and hold for 3 min.

7) Set test pressure to P_d.

8) Rotate at speed (R) continuously for one quarter (1/4) of the planned test duration (td). While rotating, reciprocate tool joint fully through the packing element(s) at (ROP) or greater speed and repeat for a minimum of 25 TJ.

   For test facilities that have the ability to reciprocate as slow as (ROP), the tool joint portion of the test mandrel must be in contact with the packing element for a proper ratio of both time and reciprocation length of the drill pipe range qualified. The reciprocation speed should be a minimum of (ROP) on pipe body and maintain an average (ROP) speed when a TJ is passing through the packing elements.

9) Reduce test pressure to 50 psi and hold for 3 min.

10) Increase test pressure to the planned drilling pressure (P_d).

11) Rotate at speed (R) continuously for one half (1/2) of the planned test duration (td). While rotating, reciprocate tool joint fully through the packing element(s) at (ROP) or greater speed and repeat for a minimum of 50 TJ.

    For test facilities that have the ability to reciprocate as slow as (ROP), the tool joint portion of the test mandrel must be in contact with the packing element for a proper ratio of both time and reciprocation length of the drill pipe range qualified. The reciprocation speed should be a minimum of (ROP) on pipe body and maintain an average (ROP) speed when a TJ is passing through the elements.

12) Stop rotation and perform a static pressure test to (P_s) and hold for 3 min.

13) Set pressure to (P_d) and continue to test to completion, time (td).

14) At time (td), stop test mandrel rotation and reciprocation such that the packing element is sealing on the pipe body portion of the mandrel and the tool joint is below the packing element.

15) Perform the final static pressure test to (P_S) and hold for 3 min.

16) End test.

A.6.4.3 Documentation

Documentation shall include a record of the following:

a) test variables from Table A.2;

b) mandrel geometry;

~~c)~~ model and serial number of all tested RCD components;

d) packing element type and conditioning data (if applicable);

e) summary of test results.

Annex B
(Informative)

Purchasing Guidelines for Rotating Control Devices

B.1 General

This annex provides recommended guidelines for inquiry and purchase of API 16RCD equipment. The test procedures in the specification 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.

B.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.

B.3 Service Conditions

B.3.1 Body Pressure Rating

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

B.3.2 Temperature Rating

B.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.

B.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.

B.3.2.3 Wellbore Elastomeric Materials

The purchaser should provide the temperature range as defined by 8.3.4.3.

B.3.2.4 Other Elastomeric Seals

The purchaser should provide the temperature range as defined by 8.3.4.3.

B.4 Outlet Connections

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

B.5 Equipment Details/Data Book

Data book shall contain the following information:

a) client purchase order number/sales order number;

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

c) date of manufacture;

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 test reports;

g) weld procedure qualification record (PQR);

h) heat treatment records;

i) NDE records, including personnel qualification records;

j) hydrostatic pressure test records.

Annex C
(Normative)

Failure Reporting

C.1 Manufacturer's Requirements

C.1.1 Manufacturer's Internal Requirements

Failures 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.

C.1.2 Manufacturer's External Recommendations

Failures experienced with RCDs furnished to this specification that prevent the equipment from meeting the functional requirements shall be reported in writing to each and every operator of the RCDs within 6 weeks after the occurrence.

The manufacturer shall communicate any design changes resulting from a malfunction, or failure history, to every known equipment owner of the affected equipment. That notice shall be within 30 days after the design change.

Bibliography

[1] API Specification 5CT, Specification for Casing and Tubing

[2] API Specification 5D, Specification for Drill Pipe

[3] API Standard 6X, Design Calculations

[4] ASQ[3] Z1.4, Sampling Procedures and Tables for Inspection by Attributes

[5] ASME[4], Boiler and Pressure Vessel Code (BPVC), Section V, Nondestructive Testing Article 5, UT Examination Methods for Materials and Fabrication

[6] ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 Appendix 4, "Rounded Indication Charts Acceptance Standard for Radiographically Determined Rounded Indications in Welds"

[7] ASME, Boiler and Pressure Vessel Code, Section VIII, Division 2 (2004 ed.): Pressure Vessel—Alternate Rules Appendix 4, "Design Based on Stress Analysis" Appendix 6, "Experimental Stress Analysis"

[8] ASNT[5], SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing, 1984 or latest Edition

[9] ASTM, A193, Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service

[10] ASTM A320, Specification for Alloy Steel Bolting Materials for Low Temperature Service

[11] ASTM A370, Test Methods and Definitions for Mechanical Testing of Steel Products

[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

[18] ASTM D575, Test Methods for Rubber Properties in Compression

[4] American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203, www.asq.org.

[4] ASME International, 2 Park Avenue, New York, NY 10016-5990, www.asme.org.

[5] American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, OH 43228, www.asnt.org.

[19] ASTM D1414, Test Methods for Rubber O-Rings

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

[21] ASTM D2084, Test Method for Rubber Property—Vulcanization Characteristics Using Oscillating Disk Cure Meter

[22] ASTM D2240, Test Method for Rubber Property—Durometer Hardness

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

[24] ASTM E18, Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

[25] ASTM E30, Test Method for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron

[26] ASTM E92, Test Method for Vickers Hardness of Metallic Materials

[27] ASTM E94, Guide for Radiographic Testing

[28] ASTM E140, Hardness Conversion Tables for Metals

[29] ASTM E165, Practice for Liquid Penetrant Examination

[30] ASTM E709, Practice for Magnetic Particle Examination

[31] ASTM E747, Guide for Controlling Quality of Radiographic Examination Using Wire Pentrameters

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

[33] MIL-STD, MIL-STD-105D, Sampling Procedures and Tables for Inspection Attributes

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