

Diverter Equipment Systems

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Foreword

The verbal forms used to express the provisions in this standard are as follows:

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Diverter Equipment Systems

1 Scope

This standard is intended to provide information on the design, manufacture, quality control, installation, maintenance and testing of the diverter system, and associated components. The diverter system provides a flow control system to direct controlled or uncontrolled wellbore fluids away from the immediate drilling area for the safety of personnel and equipment.

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 applies (including any addenda/errata).

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

API Technical Report 6AF, *Technical Report on Capabilities of API Flanges under Combinations of Loads*

API Technical Report 6AF2, *Capabilities of API flanges under Combinations of Load*

API Specification 6FA, *Specification for Fire Test for Valves*

API Standard 6D, *Specification for Pipeline and Piping Valves*

API Standard 6DX, *Standard for Actuator Sizing and Mounting Kits for Pipeline Valves*

API Standard 6X, *Design Calculations for Pressure-containing Equipment*

API Specification 16A, *Specification for Drill-through Equipment*

API Specification 16D, *Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment*

API Specification 16F, *Specification for Marine Drilling Riser Equipment*

API Specification 20E, *Alloy and Carbon Steel Bolting for use in the Petroleum and Natural Gas Industries*

API Specification 20F, *Corrosion Resistant Bolting for use in the Petroleum and Natural Gas Industries*

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard*

ASME B31.3, *Process Piping*

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*

ASME Boiler and Pressure Vessel Code (BPVC), Section V, Article 5, *UT Examination Methods for Materials and Fabrication*

ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1, Mandatory Appendix 4, *Rounded Indication Charts Acceptance Standard for Radiographically Determined Rounded Indications in Welds*

ASME Boiler and Pressure Vessel Code (BPVC), Section IX, Articles I, II, III and IV

ASTM A370, *Test Methods and Definitions for Mechanical Testing of Steel Products*

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

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

ASTM D471, *Standard Test Method for Rubber Property—Effect of Liquids*

ASTM D1414, *Standard Test Methods for Rubber O-Rings*

ASTM D1415, *Standard Test Method for Rubber Property—International Hardness*

ASTM D2240, *Test Method for Rubber Property—Durometer Hardness*

ASTM E10, *Standard Test Method for Brinell Hardness of Metallic Materials*

ASTM E18, *Standard Test Method for Rockwell Hardness of Metallic Materials*

ASTM E94, *Standard Guide for Radiographic Testing*

ASTM E110, *Standard Test Method for Indentation Hardness of Metallic Materials by Portable Hardness Testers*

ASTM E140, *Hardness Conversion Tables for Metals*

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

ASTM E384, *Standard Test Method for Knoop and Vickers Hardness of Materials*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASNT SNT-TC-1A, *Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing*

TWI CSWIP-WI-6-92, *Requirements for the Certification of Visual Welding Inspectors (Level 1), Welding Inspectors (Level 2) and Senior Welding Inspectors (Level 3) (fusion welding)* in accordance with the requirements of BS EN ISO 17637:2011

ISO 6506-1, *Metallic materials—Brinell hardness test—Part 1: Test method*

ISO 6507-1, *Metallic materials—Vickers hardness test—Part 1: Test method*

ISO 6508-1, *Metallic materials—Rockwell hardness test—Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892, *Metallic materials—Tensile testing at ambient temperature*

ISO 9712, *International Standard for Nondestructive Testing Personnel Qualification and Certification*

ISO 18265, *Metallic materials—Conversion of hardness values*

3 Terms, Definitions and Acronyms

3.1 Terms and Definitions

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

3.1.1**acceptance criteria**

Defined limits placed on characteristics of materials, products or service.

3.1.2**actuator****(valve actuator)**

Device used to open or close a valve by means of applied manual, hydraulic, pneumatic or electrical energy.

3.1.3**annular preventer**

Device that can seal around any object in the wellbore or upon itself.

NOTE Compression of a reinforced rubber/elastomer packing element by hydraulic pressure effects the seal.

3.1.4**annular sealing device**

Assembly containing a packing element that facilitates closure of the annulus by constricting to seal on the tubular in the wellbore.

NOTE 1 Some annular sealing devices also facilitate shutoff of the open hole.

NOTE 2 Examples include, but not limited to, diverter assemblies, annular preventer, and overshot packer systems.

3.1.5**annulus**

Space between the outer diameter of the drill string and the inside diameter of the hole being drilled, the last string of casing set in the well or the marine riser.

3.1.6**bell nipple**

Piece of pipe, with inside diameter equal to or greater than the BOP bore, connected to the top of the BOP or marine riser with a side outlet to direct the drilling fluid returns to mud processing equipment.

NOTE Usually has a second side outlet for the fill-up line connection.

3.1.7**blowout preventer (BOP) stack**

Assembly of well control equipment including preventers, spools, valves, and nipples connected to the top of the casing head that allows the well to be sealed to confine well fluids to the wellbore.

3.1.8**body**

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

3.1.9**bolting**

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

— primary bolting

Bolting in the load path or bolting that connects flow-direction-controlling members.

— closure bolting

Threaded fasteners used to assemble wellbore pressure-containing parts or that join end or outlet connections.

— utility bolting

Bolting required for mounting equipment and accessories to the diverter equipment not identified as primary bolting.

NOTE Examples include bolting on nameplate, clamps for tubing, guards, etc.

3.1.10

bottom-hole assembly

That part of the drill string located directly above the drill bit.

NOTE The components primarily include drill collars and other specialty tools such as stabilizers, reamers, drilling jars, bumper subs, heavy weight drill pipe, etc.

3.1.11

corrosion-resistant alloy

CRA

Alloy intended to be resistant to general and localized corrosion when subject to oilfield environments.

3.1.12

corrosion-resistant ring groove

Ring groove lined with a CRA or an austenitic stainless steel to resist metal-loss corrosion.

3.1.13

date of manufacture

Date of the manufacturer's final acceptance of finished equipment.

3.1.14

diverter

diverter assembly

Device used to direct flow from the wellbore to the pre-selected side outlet(s).

NOTE 1 Upon activation, the diverter assembly seals the vertical flow path to prevent hydrocarbons from reaching the rig floor and normally diverts flow to the overboard line(s).

NOTE 2 When deactivated, the diverter assembly allows for fluid returns to the flow line for normal drilling operations.

3.1.15

diverter control system

Assemblage of pumps, accumulators, manifolds, control panels, valves, lines, etc., used to operate the diverter system.

3.1.16

diverter housing

If part of the diverter design, the interface between the diverter assembly and the required piping.

NOTE The diverter housing handles the loads between the rig and the riser system, and provides the sealing surface and the lockdown mechanism for the diverter assembly.

3.1.17**diverter spool**

Device to direct an uncontrolled flow which may generate from a shallow zone during well drilling activities.

NOTE A diverter spool is used on a surface application below a diverter prior to the installation of blowout prevention equipment.

3.1.18**diverter system**

Assemblage of an annular sealing device, flow control means, and overboard system components which facilitates closure of the upward flow path of the well fluid and opening of the overboard line to divert the fluid flow to the environment away from the rig floor.

NOTE Components include, but not limited to, diverter, diverter control system, valve(s), side outlets, and flow/overboard lines.

3.1.19**end connection**

Integral male or female thread; clamp hub end connector or flange, studded or through-bolted, or any other means used to join together equipment that contains or controls pressure.

3.1.20**equivalent round**

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

3.1.21**fill-up line**

Line connected into the bell nipple or diverter housing allowing drilling fluid to be added to the hole.

3.1.22**flange**

Protruding rim, with holes to accept bolts and having a sealing mechanism, used to join pressure-containing equipment.

3.1.23**flow-direction-controlling member**

System component that contains and directs wellbore fluid flow.

3.1.24**flow selector**

Three-way valve with switchable target designed to divert wellbore fluids while keeping a diverter overboard line always open.

3.1.25**flow line**

Piping that exits the bell nipple or diverter housing, and conducts drilling fluid and cuttings to the mud processing equipment.

3.1.26**flow line seal**

Elastomeric element that creates a seal between the diverter housing and diverter assembly.

3.1.27**flow line valve**

Valve that controls the flow of drilling fluid through the flow line.

3.1.28**fluid cushion**

Cavity in a piping system used to absorb impact of flow direction change to mitigate erosion.

3.1.29**full-opening valve**

Valve with an unobstructed opening, not smaller than the internal bore of the end connections.

3.1.30**function test**

Closing and opening (cycling) equipment to verify operability.

3.1.31**heat-affected zone****HAZ**

Portion of the base metal that has not been melted, but whose mechanical properties or microstructure has been altered by the heat of welding or cutting.

3.1.32**heat treatment****heat treating**

Specified, timed sequence of controlled heating and cooling of metallic materials for the purpose of obtaining desired physical or mechanical properties.

3.1.33**hot-work [verb]**

Deform metal plastically at a temperature above the recrystallization temperature.

3.1.34**indication**

Visual sign of cracks, pits or other abnormalities found during liquid penetrant and magnetic particle examinations.

3.1.35**leakage**

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

3.1.36**linear indication**

Liquid penetrant or magnetic particle examination indication whose length is equal to or greater than three times its width.

3.1.37**load-bearing weldments**

Weldments subjected to external loads.

3.1.38**load path**

Direction in which each consecutive load propagates through connected members.

3.1.39**maintenance**

Upkeep of well control equipment that is performed in accordance with the equipment owner's PM program and the manufacturer's guidelines.

NOTE 1 These procedures may include, but are not limited to: inspections, cleaning, polishing, function testing, pressure testing, non-destructive examination, change out of sealing parts, and those parts defined in the PM program to be changed either periodically or on a cycle basis.

NOTE 2 Maintenance does not include machining, welding, heat treating or other manufacturing operations.

3.1.40**major repair weld**

Weld whose depth is greater than 25 % of the original wall thickness or 25 mm, whichever is less.

3.1.41**other end connection****OEC**

Connection that is not specified in an API Specification or Standard.

NOTE Other end connection includes API flanges and hubs with non-API gasket preparations and manufacturer's proprietary connections that are designed and manufactured in accordance with API 16A.

3.1.42**overshot packer system**

Adjustable spacer spool consisting of an overshot spool with sealing packer and a lower overshot mandrel that is designed and manufactured in accordance with API 16A.

3.1.43**packing element**

Rubber/elastomer element that affects a seal in an annular preventer, diverter or other annular sealing device.

NOTE A packing element is also an elastomer used in valves or lubricators to effect a seal.

— annular packing element

Torus-shaped rubber/elastomer element that affects a seal in an annular preventer or diverter.

NOTE The annular packing element is displaced toward the bore center by the upward movement of an annular piston.

— insert packing element

Cylindrical shaped rubber/elastomer element that affects a seal in a diverter.

NOTE The insert-type packing element is displaced toward the bore center by an external load, typically actuated by hydraulics.

— diverter packer

Sealing component consisting of a rubber/elastomer element that effects a seal in through bore of a diverter.

3.1.44**post-weld heat treatment****PWHT**

Any heat treatment subsequent to welding, including stress relief.

3.1.45**pressure-containing part**

Part exposed to fluids whose failure to function as intended would result in a release of fluid to the environment.

NOTE Examples include bodies, clamp bolts, bonnets, connecting rods, packing elements, and replaceable seals within a pressure-containing member or part.

3.1.46**prod**

Pointed rod used to induce a magnetic field onto a surface for inspection purposes.

3.1.47**product history file****PHF**

Composite file of records from a traceable API product which includes all records associated with the API product repair and remanufacturing, including certification records required by this Standard.

3.1.48**rated load**

Nominal applied loading conditions used during design, analysis, and testing based on maximum anticipated service load.

3.1.49**rated working pressure**

Maximum internal pressure that the equipment is designed to contain or control or a combination thereof.

3.1.50**technical authority**

Competent and technically qualified person or organization with evidence to demonstrate the expertise, skills, and experience regarding design, quality, and manufacturing processes necessary to perform the required verification(s).

3.1.51**relevant indication**

Surface NDE indication (Liquid penetrant or magnetic particle examination) with a major dimension greater than 1.6 mm (0.062 in.).

NOTE Inherent indications not associated with a surface rupture are considered non-relevant indications.

3.1.52**remanufacture**

Activity involving disassembly, reassembly and testing of equipment, with or without the replacement of parts, in which machining, welding, heat treating or other manufacturing operations are employed.

3.1.53**repair**

Activity involving disassembly, reassembly, or replacement of components and testing of equipment after the failure of a piece of equipment.

NOTE Repair does not include machining, welding, heat treating or other manufacturing operations.

3.1.54**rounded indication**

For liquid penetrant or magnetic particle examination—any indication that is approximately circular or elliptical and whose length is less than three times its width.

For radiographic examination—any indication with a maximum length of three times the width or less on the radiograph.

NOTE Indications may be circular, elliptical, conical or irregular in shape and may have tails. When evaluating the size of an indication, the tail is included.

3.1.55**serialization**

Assignment of a unique code to individual parts or pieces, or a combination thereof, of equipment to maintain records.

3.1.56**stabilized**

For pressure testing—state in which the initial pressure-decline rate has decreased to within a specified rate.

NOTE 1 Pressure decline can be caused by such things as changes in temperature, setting of elastomer seals or compression of air trapped in the equipment being tested.

For temperature testing—state in which the initial temperature fluctuations have decreased to within a specified range.

NOTE 2 Temperature fluctuation can be caused by such things as mixing of different-temperature fluids, convection or conduction.

3.1.57**stress relief**

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

3.1.58**studded connection**

Connection in which thread-anchored studs are screwed into tapped holes.

3.1.59**subsea diverter**

Diverter system installed above marine drilling riser.

3.1.60**surface diverter**

Diverter system not installed above marine drilling riser.

3.1.61**target flange**

Bull plug or blind flange to prevent erosion at a point where change in flow direction occurs.

3.1.62**targeted**

Refers to a fluid piping system in which flow impinges upon an erosion-resistant end (target flange) when fluid transits a change in direction.

3.1.63**telescopic joint
slip joint**

Riser joint having an inner barrel and an outer barrel with sealing means between the two barrels.

NOTE 1 The inner barrel is attached to the flexible joint beneath the diverter and the outer barrel is attached to tensioner lines.

NOTE 2 The inner and outer barrels of the telescoping joint move relative to each other to compensate for the required change in the length of the riser string as the vessel moves.

3.1.64**trepan [verb]**

To produce a hole through a part by boring a narrow band or groove around the circumference of the hole, and removing the solid central core of material.

3.1.65**overboard line
vent line**

Conduit that directs the flow of diverted wellbore fluids away from the drill floor to the environment.

3.1.66**overboard line valve**

Full-opening valve that facilitates the shut-off of flow or allows passage of diverted wellbore fluids through the overboard line.

3.1.67**overboard outlet**

Point at which fluids exit the wellbore below the annular sealing device via the overboard line.

3.1.68**weld groove**

Area between two metals to be joined and has been prepared to receive weld filler metal.

3.1.69**wellhead**

Component or structure installed to provide an interface between casing and well control equipment.

3.1.70**wrought structure**

Structure that contains no cast dendritic structure.

3.1.71**yield strength**

Stress level, measured at room temperature, at which material plastically deforms and does not return to its original dimensions when the stress is released.

NOTE 1 Yield Strength is expressed in pounds per square inch of loaded area.

NOTE 2 All yield strengths specified in this Standard are considered as being the 0.2 % yield offset strength in accordance with ASTM A370 or ISO 6892.S.

3.2 Acronyms

For the purposes of this document, the following acronyms apply:

AE	acoustic emission
ANSI	American National Standards Institute
AISI	American Iron and Steel Institute
AQL	acceptance quality level
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BPVC	Boiler and Pressure Vessel Code
CE	carbon equivalent
CRA	corrosion resistant alloy
CSO	complete shut-off
DAC	distance amplitude curve
EP	equivalent P-number
ER	equivalent round
FAT	Factory Acceptance Test
FEA	Finite Element Analysis
HAZ	heat affected zone
IADC	International Association of Drilling Contractors
ID	inside diameter
IOM	Installation, Operation, and Maintenance
ISO	International Organization for Standardization
ITP	inspection test plan
LP	liquid penetrant
MP	magnetic particle
MDB	material data book
NDE	non-destructive examination
OD	outside diameter

OEC	other end connection
OEM	original equipment manufacturer
PHF	product history file
PM	preventive maintenance
PQR	procedure qualification record
PWHT	post-weld heat treatment
QTC	qualification test coupon
RWP	rated working pressure
SST	austenitic stainless steel
WPS	welding procedure specification

4 Diverter System Size Designation

Nominal diverter size and corresponding drift diameter(s) shall be agreed upon by manufacturer and purchaser.

NOTE Sizing may be based on nominal rotary table size.

5 Component Design Methodology

5.1 General

NOTE 1 This Section shall apply to the design and manufacture of new diverter equipment. This Section is not intended to apply to equipment manufactured before the date of publication of this document.

The design methodology as described in API 6X shall be used together with equipment manufacturer's specifications.

NOTE 2 The use of von Mises equivalent stress is permitted.

5.2 Service Conditions

5.2.1 Rated Working Pressure

Equipment covered in this standard shall be designed and manufactured for a minimum rated working pressure of 3.45 MPa (500 psi).

5.2.2 Temperature Ratings

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

Equipment shall be designed for wellbore elastomeric materials to operate within the temperature classifications of Table 2.

The low temperature shall be the lowest temperature to which the equipment may be subjected.

Table 1—Temperature Rating for Metallic Materials

Classification	Operation Range	
	°C	°F
T-75/250	–59 to 121	–75 to 250
T-75/350	–59 to 177	–75 to 350
T-20/250	–29 to 121	–20 to 250
T-20/350	–29 to 177	–20 to 350
T-0/250	–18 to 121	0 to 250
T-0/350	–18 to 171	0 to 350
NOTE Information on strength of materials at elevated temperatures is found in API 6A and API 6MET.		

Table 2—Temperature Rating for Non-metallic Materials

Low Temperature Limit (first digit)			Continuous Elevated Temperature Limit (second digit)			Extreme Temperature Limit (third digit)		
Code	Temperature		Code	Temperature		Code	Temperature	
	°F	°C		°F	°C		°F	°C
A	–15	–26	A	150	66	A	180	82
B	0	–18	B	180	82	B	200	93
C	10	–12	C	210	99	C	220	104
D	20	–7	D	240	116	D	250	121
E	30	–1	E	270	132	E	300	149
F	40	4	F	300	149	F	350	177
G	Other	Other	G	Other	Other	G	Other	Other
EXAMPLE Material “FDE” has a low temperature rating of 40 °F (4 °C), a continuous elevated temperature rating of 240 °F (116 °C), and an extreme temperature limit of 300 °F (149 °C).								

The continuous elevated temperature limit shall be the maximum average fluid temperature allowed over a ten pressure cycle period.

The extreme temperature limit shall be the maximum fluid temperature to which the equipment may be subjected over a one-hour period.

5.2.3 Rated Service Range

The manufacturer shall specify the range of tubulars for each size/type of diverter packer. The minimum and maximum tubular sizes shall define the rated service range.

NOTE Equipment capable of complete shut-off (CSO) may designate “CSO” for the minimum size.

5.2.4 Load Rating

Diverter and attachments shall be evaluated for:

- hang-off load capacity;
- up-thrust load;
- additional loads as defined by purchaser:
 - bending moments;
 - dynamic loading from vessel motion;
 - horizontal forces (such as equipment motion).

5.3 Diverter Housing

5.3.1 General

Diverter housings attached to the rig's substructure shall be designed such that the loads generated by the diverted fluid are directed into the substructure.

Hang-off load capacity shall be defined through calculation or FEA or both. Additional loads acting on the housing such as bending moments, dynamic loading from vessel motion or horizontal forces (such as equipment motion) shall be defined by the purchaser.

Housing side outlet connections to the wellbore shall not be threaded. Housing side outlet connections shall be specified by the customer or shall conform to the dimensional requirements of API 6A or ASME B16.5, or a combination thereof.

NOTE Side outlet connections should be designed to reduce erosion.

5.3.2 Weldability of the Attachment Bars to the Substructure

Attachment bar material shall be readily weldable without PWHT. Welding shall be performed using a weld procedure qualified for the materials to be welded.

The bars shall be welded along a minimum of two sides for the full length, to distribute the bolting load evenly to the beams. Both ends of the attachment bar shall be seal welded.

The weld of the attachment bars to the rig substructure shall be designed to meet the designed load rating of the diverter system.

5.4 Diverter Assembly

Diverter assemblies shall be designed to land and lock within the diverter housing. The assembly shall seal to the housing and provide a flowpath to the diverter outlets.

Diverter assembly shall be capable of transferring loads to housing as defined by the purchaser. The diverter assembly shall actuate the diverter packer to close off on a designated pipe size or open hole if applicable.

5.5 Diverter Packer

5.5.1 General

The diverter packer shall create a wellbore seal and divert the upward flowpath of well fluids.

NOTE 1 Two types of sealing devices or packer elements commonly used in diverters are described in 5.5.2 and 5.5.3.

NOTE 2 Though some diverters and their packer elements are designed for complete shut-off, others are designed to seal only on a specified range of pipe diameters.

5.5.2 Annular Type Packing Unit

An annular packing element (see Figure 1) shall seal on the range of tubulars specified by the manufacturer and may seal on an open hole if no pipe is present.

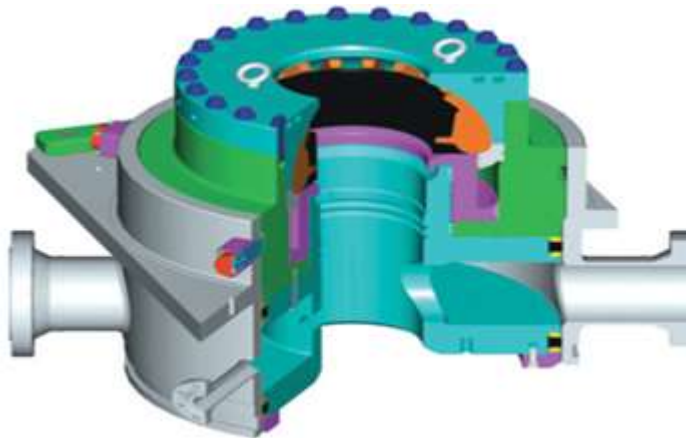


Figure 1—Example Diverter with an Annular Packing Unit

NOTE The packing element moves radially inward when a hydraulic “close” pressure is applied to the diverter.

The packing element shall relax to the open position when hydraulic “open” pressure moves the operating piston to the open position.

The annular packing element shall be of sufficient internal diameter in the fully open position to pass the drift.

Drift diameter shall be 0.060 in. less than the nominal diverter bore diameter with a tolerance of ± 0.030 in.

5.5.3 Insert Packing Element

NOTE 1 An insert packing element (see Figure 2) uses inserts that can close and create a seal on ranges of pipe diameters.

A hydraulic or mechanical lock shall latch the insert packer in place.

NOTE 2 The insert packer may be removed to pull or run the bottom-hole assembly (see Figure 2).

The manufacturer shall define a procedure to verify that the insert packer is properly locked in place each time the packer is inserted.