

Practices for Side-pocket Mandrels and Related Equipment

ANSI/API RECOMMENDED PRACTICE 19G4
FIRST EDITION, JUNE 2011

REAFFIRMED, JANUARY 2019

ISO 17078-4:2010 (Identical), Petroleum and natural gas industries—Drilling and production equipment, Part 4—Practices for side-pocket mandrels and related equipment



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API Foreword

The API Subcommittee on Offshore Structures (SC 2) voted to adopt a modified version of ISO 19901-4:2003 as American National Standard ANSI/API Recommended Practice 2GEO. These modifications from the ISO standard have been incorporated directly into the text and marked with a change bar in the margin.

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 17078-4 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

ISO 17078 consists of the following parts, under the general title *Petroleum and natural gas industries — Drilling and production equipment*:

- *Part 1: Side-pocket mandrels* (API 19G1)
- *Part 2: Flow-control devices for side-pocket mandrels* (API 19G2)
- *Part 3: Running tools, pulling tools and kick-over tools and latches for side-pocket mandrels* (API 19G3)
- *Part 4: Practices for side-pocket mandrels and related equipment* (API 19G4)

Introduction

This part of ISO 17078 has been developed by users/purchasers and suppliers/manufacturers of subsurface side-pocket mandrels, flow-control devices used in side-pocket mandrels (hereafter called flow-control devices), and associated latches and installation tools that are used in conjunction with side-pocket mandrel flow-control devices. This equipment is intended for use in the worldwide petroleum and natural gas industry. This part of ISO 17078 is intended to provide supporting information, guidelines and practices to all parties who are involved in the specification, selection, manufacture, testing and use of side-pocket mandrels, flow-control devices and associated latches and installation tools.

In addition to this part of ISO 17078, ISO 17078-1 provides requirements for side-pocket mandrels used in the petroleum and natural gas industry. ISO 17078-2 provides requirements for flow-control devices. And, ISO 17078-3 provides requirements for latches and installation tools that are used in conjunction with side-pocket mandrel flow-control devices. Other pertinent side-pocket mandrel-related information can be found in API standards listed in the bibliography.

It is necessary that users of this part of ISO 17078 be aware that requirements above those outlined in this part of ISO 17078 can be needed for individual applications. This part of ISO 17078 is not intended to inhibit a supplier/manufacture from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the supplier/manufacture to identify any variations from this part of ISO 17078 and provide details.

Petroleum and natural gas industries — Drilling and production equipment —

Part 4: Practices for side-pocket mandrels and related equipment

1 Scope

This part of ISO 17078 provides informative documentation to assist the user/purchaser and the supplier/manufacture in specification, design, selection, testing, calibration, reconditioning, installation and use of side-pocket mandrels, flow-control devices and associated latches and installation tools. The product-design and manufacturing-related requirements for these products are included within the other parts of ISO 17078.

The content and coverage of several industry documents are compiled and refined within ISO 17078 (all parts).

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.

ISO 14313, *Petroleum and natural gas industries — Pipeline transportation systems — Pipeline valves*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 17078-1:2004, *Petroleum and natural gas industries — Drilling and production equipment — Part 1: Side-pocket mandrels*

ISO 17078-2:2007, *Petroleum and natural gas industries — Drilling and production equipment — Part 2: Flow-control devices for side-pocket mandrels*

ISO 17078-3:2009, *Petroleum and natural gas industries — Drilling and production equipment — Part 3: Running tools, pulling tools and kick-over tools and latches for side-pocket mandrels*

ANSI/ASME B16.5, *Pipe Flanges and Flanged Fittings*

ANSI/ASME B16.34, *Valves Flanged, Threaded and Welding End*

ANSI/ASME B31.8, *Gas Transmission and Distribution Piping Systems*

ANSI/API MPMS 14.31-1990, *Dimensioning and Tolerancing*

GPA 8185-90, *Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluid, Part 1, General Equations and Uncertainty Guidelines*, American Gas Association, Report No. 3

ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Pressure Vessels, Division 1, *Rules for Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Pressure Vessels, Division 2, *Alternative Rules*

3 Terms and definitions

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

NOTE For quality-system-related terms used in this part of ISO 17078 and not defined below, reference can be made to ISO 9000 for additional definitions.

3.1

acceptance

flow-control device, component(s) and/or assembly(s) accepted for use

3.2

acceptance criteria

measures or conditions that shall be met for a test to be successful

3.3

ager

pressure chamber used to externally pressure test a flow-control device for a specified period of time and/or number of cycles

3.4

coating

application of a film of material on the surface of another material for different purposes

3.5

compatibility testing

testing to confirm that various side-pocket mandrels and related products fit and work together

3.6

critical length

linear distance in a side-pocket mandrel between orienting sleeve no-go and face of pocket, measured perpendicular to face of pocket

3.7

design verification grade

levels of design requirements for side-pocket mandrels and associated equipment in accordance with ISO 17078-1, ISO 17078-2, and ISO 17078-3

3.8

dome

chamber that contains an internal pressure that is applied to the responsive element, which may be a bellows or piston

3.9

dummy flow-control device

blank device that is installed in a side-pocket mandrel to prevent flow or pressure communication between the casing annulus and the tubing

3.10

gas port

holes in a side-pocket mandrel where gas enters the pocket of the mandrel

3.11

informative

information that is meant to enlighten the user/purchaser or supplier/manufacture, without containing requirements

3.12

injection pressure operated

injected-gas-pressure-operated flow-control device

3.13**latch**

retention mechanism for a flow-control device that is installed in a side-pocket mandrel

3.14**linear mass**

mass per length of tubular product

3.15**loading conditions**

loading conditions that it is anticipated to apply to the side-pocket mandrel, including, but not limited to, tensile and compressive loads, internal (burst) pressures, external (collapse) pressures, bending stresses, etc.

3.16**manufacturing**

process(es) and action(s) performed by an equipment supplier/manufacture that are necessary to provide finished component(s), assemblies and related documentation that fulfil the requests of the user/purchaser, and to meet the standards of the supplier/manufacture

NOTE Manufacturing begins when the supplier/manufacture receives the order and is completed at the moment the component(s), assembly(ies), and related documentation are transferred to a transportation provider.

3.17**model**

name and/or description of a device that has unique components and functional characteristics and that distinguish it from other models of the same type

3.18**operating environment**

set of environmental conditions that the product is exposed to during its service life, including, but not limited to, such environmental variables as temperature, pressure, liquid composition and properties, gas composition and properties, solids, etc.

3.19**operational parameters**

requirements and restrictions to which the product is exposed during its service life

EXAMPLES Operating environment, landing and retrieval of flow-control devices, injection of various well treatment chemicals/fluids, etc.

3.20**product functional testing**

process, method(s) and/or test(s) that are used by the supplier/manufacture to demonstrate that a particular device has been manufactured to fully meet the functional and manufacturing requirements for that product as defined by the appropriate ISO specifications

3.21**production pressure operated**

production-pressure-operated flow-control device

3.22**quality control grade**

process and/or method(s) used by the supplier/manufacture to assure the quality of the materials, manufacturing process(es) and traceability as defined in the appropriate ISO specifications

3.23**rated pressure**

specified pressure, at a specified temperature, at which the flow-control device is designed to operate

- 3.24**
rated temperature
specified temperature, at a specified pressure, at which the flow-control device is designed to operate
- 3.25**
reconditioning
inspection, repair and test of used products to establish a minimum level of assurance of performance to defined standards
- 3.26**
Système International (French)
SI
system of units used by preference in the ISO International Standards documents
- 3.27**
side-pocket mandrel
tubing-conveyed device that accepts a flow-control or other device in a bore that is offset and essentially parallel with the through bore of the tubing product
- NOTE This bore includes sealing surfaces and latching profiles.
- 3.28**
supplier/manufacturer
company, organization or entity that designs, manufactures and/or markets flow-control device products
- 3.29**
technical specifications
parameters stating the operating limit(s) relating to the design, assembly and testing of the component parts or assemblies
- 3.30**
test pressure
maximum rated pressure at test temperature, as specified by the pertinent test procedure
- 3.31**
test temperature
temperature at which the test is conducted, as specified by the pertinent test procedure
- 3.32**
user/purchaser
company, organization or entity that purchases, installs and uses flow-control devices
- 3.33**
wireline
equipment and associated technique(s) used to install and retrieve flow-control devices in a well using a continuous length of solid line (slick line) or stranded wire, appropriate spooling equipment at the surface and a specialized tool string attached to the end of the wire

4 Abbreviations and symbols

4.1 Abbreviations

Abbreviations used within this part of ISO 17078 are defined as follows:

- ANSI American National Standards Institute
- ASME American Society of Mechanical Engineers
- IPO Injection pressure operated

- NORM naturally occurring radioactive material
- P&ID piping and instrumentation diagram
- PPO Production pressure operated
- RP Recommended practice
- SC Standard conditions, assumed to be 101 kPa (14.73 psia) and 15.5 °C (60 °F)

4.2 Symbols

Symbols used within this part of ISO 17078 are defined as follows:

- A_b effective bellows area, expressed in square centimetres (square inches)
- A_p area based on the nominal port diameter, expressed in square centimetres (square inches)
- A_s area based on the diameter where the stem contacts the seat, expressed in square centimetres (square inches)
- C_v flow coefficient
- F_k specific heat factor, equal to $k/1.40$
- k ratio of specific heats of lift gas
- P_{trc} measured or calculated gauge pressure required to close the flow-control device and prevent flow at 15.5 °C (60 °F)

NOTE 1 Referred to as the flow-control-device test-rack closing pressure at standard temperature, expressed in gauge kilopascals (pounds per square inch). A special fixture is required to generate this value as the upstream pressure is reduced until the flow-control device is closed.

- P_{tro} measured or calculated gauge pressure applied over the area $(A_b - A_s)$, required to initiate flow through a flow-control device with zero gauge pressure downstream at 15.5 °C (60 °F)

NOTE 2 Referred to as the flow-control-device test-rack opening pressure at standard temperature, expressed in gauge kilopascals (pounds per square inch).

- P_{vc} measured or calculated upstream gauge pressure when the downstream pressure is equal to the upstream pressure and near-zero gas flow rate at 15.5 °C (60 °F)

NOTE 3 Referred to as the flow-control-device closing pressure at standard temperature, expressed in gauge kilopascals (pounds per square inch).

- P_{vcT} measured or calculated upstream gauge pressure when the downstream pressure is equal to the upstream pressure and near-zero gas flow rate at a known temperature

NOTE 4 Referred to as the flow-control-device closing pressure at a known temperature, expressed in gauge kilopascals (pounds per square inch).

- P_{voT} measured or calculated gauge pressure applied over the area $(A_b - A_s)$, required to initiate flow through a flow-control device with zero gauge pressure downstream at a known temperature

NOTE 5 Referred to as the flow-control-device opening pressure at a known temperature, expressed in gauge kilopascals (pounds per square inch).

$R_{p,crt}$ critical-pressure ratio factor, the pressure ratio factor at which the velocity of fluid exceeds the local speed of sound

NOTE 6 Critical flow occurs when $F_k \times R_{p,crt}$ equals or exceeds the pressure ratio. The value is determined in accordance with ISO 17078-2:2007, Annex H.

5 Guidelines for application of side-pocket mandrels and related equipment

5.1 General

Guidelines to assist users/purchasers and suppliers/manufacturers in the application of side-pocket mandrels and related products are included in the annexes as referenced in 5.2 to 5.9.

5.2 Interface compatibility issues

The user/purchaser may use the guidelines in Annex A to understand the limits of compatibility testing as used in ISO 17078-1, ISO 17078-2 and ISO 17078-3.

NOTE 1 For the purposes of this provision, API 19G1 is equivalent to ISO 17078-1.

NOTE 2 For the purposes of this provision, API 19G2 is equivalent to ISO 17078-2.

NOTE 3 For the purposes of this provision, API 19G3 is equivalent to ISO 17078-3.

5.3 Test facility for flow-control-device performance testing

The user/purchaser or supplier/manufacture may use the guidelines in Annex B to assist in set-up of sites for performance testing of flow-control devices.

5.4 Set-up and calibration of flow-control devices

The user/purchaser or supplier/manufacture may use the guidelines in Annex C to assist in set-up and/or calibration of flow-control devices.

5.5 Pre-installation and post-removal inspection, testing, and maintenance

The user/purchaser or supplier/manufacture may use the guidelines in Annex D to assist in pre- and post-removal inspection, testing and maintenance of side-pocket mandrels and related devices, such as flow-control devices, running, pulling, and kick-over tools and latches.

5.6 Reconditioning side-pocket mandrels and related products

The user/purchaser or supplier/manufacture may use the guidelines in Annex E to assist in reconditioning of side-pocket mandrels and related devices, such as flow-control devices, running, pulling, and kick-over tools and latches.

5.7 Reconditioning shops and shop personnel

The user/purchaser or supplier/manufacture may use the guidelines in Annex F to assist in set-up and staffing of facilities for set-up, calibration and/or reconditioning of side-pocket mandrels and related devices, such as flow-control devices, running, pulling, and kick-over tools and latches.

5.8 User/purchaser functional specification templates

The user/purchaser may use the guidelines and blank templates in Annex G (and also provided as separate revisable electronic files) to assist in compiling and providing the information that is required when ordering side-pocket mandrels and related products, such as flow-control devices, running, pulling, and kick-over tools and latches. However, use of these templates is not required. They are offered as a convenience for the user/purchaser. If one or more of these templates is used, it shall be used as specified in Annex G.

5.9 Supplier/manufacturer product data sheets

The supplier/manufacturer may use the guidelines and blank templates in Annex H (and also provided as separate revisable electronic files) to assist in compiling and providing the information that is required when providing side-pocket mandrels and related products, such as flow-control devices, running, pulling, and kick-over tools and latches. However, use of these templates is not required. If one or more of these templates is used, it shall be used as specified in Annex H.

Annex A **(informative)**

Interface compatibility issues

A.1 General

This annex presents guidelines for interface compatibility issues between side-pocket mandrels and related equipment. It is the responsibility of the user/purchaser to assure compatibility between the various tools if components are selected from different suppliers/manufacturers.

A.2 Interface compatibility

A.2.1 General

Each component in a gas-lift or side pocket equipment system, including the side-pocket mandrel, flow-control device and the tools used for installation and retrieval (running, pulling, and kick-over tool, and latch) shall be dimensionally compatible with each other to work correctly. Normally, dimensional compatibility between components is only assured within the product line of a particular supplier/manufacture, unless a supplier/manufacture runs specific tests to demonstrate compatibility with components from a different supplier/manufacture with which compatibility is claimed. Examples of such tests are provided in this International Standard (all parts).

If a user/purchaser chooses to use equipment from different suppliers/manufacturers, the user/purchaser can require that dimensional compatibility between the components be proven. A recommended way to do this is to require that the suppliers/manufacturers demonstrate dimensional compatibility by performing interface validation tests.

A.2.2 Validated compatibility

All components are made by one supplier/manufacture, and that supplier/manufacture proves, through ISO-specified design validation compatibility testing, that all of its components fit and work together.

A.2.3 Claimed compatibility

Components are provided by different suppliers/manufacturers, but each supplier/manufacture has proven compatibility with each component for which compatibility is claimed. The ISO-specified functional compatibility tests are a recommended way to do this.

A.2.4 Unconfirmed compatibility

Components are provided by several different suppliers/manufacturers that do not claim interface compatibility. In this case, interface compatibility of all components should be demonstrated by functional testing before installation. The ISO-specified functional compatibility tests are a recommended way to do this.

A.2.5 Degree of assurance by different design validation grades

For most components, the ISO standards provide differing “degrees of assurance” by the design validation grades V3, V2, and V1 for side-pocket mandrels, flow-control devices, latches and associated tools. Each user/purchaser shall be aware of the requirements of each grade and specify the grade necessary to assure the interface compatibility that is required. For some components, grade V1 requires a tolerance-accumulation study with all required tolerances, including the specific design tolerances of the side-pocket mandrel, the flow-control device and the latch. It is unlikely that this requirement can be met in cases where components are provided by different suppliers/manufacturers.

Annex B (informative)

Test facilities for flow-control device performance testing

WARNING — The use of this part of ISO 17078 can involve hazardous operations and equipment. This part of ISO 17078 does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this part of ISO 17078 to establish appropriate skill levels for personnel performing the procedures and the applicability of safety and health practices.

B.1 Scope

This annex provides recommendations for test facilities used in performance testing of flow-control devices. It outlines the equipment required for testing flow-control devices to determine

- a) the flow-control device flow coefficients, C_v ;
- b) the pressure-drop ratio factor, X_t ;
- c) the gas-lift flow-control-device performance curves.

B.2 Test facility

B.2.1 General guidelines

B.2 outlines the testing facility necessary to perform flow-control device testing. The type of testing anticipated requires a high-volume, high-pressure source of gas. It is suggested that the gas storage device be at least 2.83 m³ (100 ft³) and the pressure be at least 10 432 kPa (1 500 psi).

Applicable codes and practices should be followed when constructing the facility. The piping, flow-control devices and surge vessels that comprise the gas-lift flow-control-device testing system are subjected to high-pressure gas. Therefore, the fabrication, testing, and flow-control device selections shall adhere to the established codes governing piping systems and vessels.

Surge or other vessels with diameters exceeding 152 mm (6 in) shall adhere to ANSI/ASME BPVC, Section VIII, Divisions 1 and 2. These provide requirements for design, fabrication, inspection and certification of applicable vessels.

The specifications for piping, including materials, wall thickness and related pressure ratings, shall be in accordance with ANSI/ASME B31.8, *Gas Transmission and Distribution Piping Systems* and addenda. Piping material shall be specified as Grade B; flanges shall be in accordance with ANSI/ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 through 24"* and any addenda; flow-control devices shall be in accordance with ANSI/ASME B16.34, *Valves Flanged, Threaded and Welding End*.

Other components are covered by ISO 14313.

NOTE For the purposes of this provision, API Spec 6D is equivalent to ISO 14313.

These components may be used; however, it is possible that they are not interchangeable with ANSI/ASME flanges, so caution should be used if attempting to mix equipment covered by different codes.

All testing shall be performed by personnel who have been qualified as having the required skills and abilities to conform to the requirements of this part of ISO 17078.