

Specification for Completion Accessories

ANSI/API SPECIFICATION 19AC
FIRST EDITION, SEPTEMBER 2016

CONTAINS API MONOGRAM ANNEX AS PART OF U.S. NATIONAL
ADOPTION

REAFFIRMED, FEBRUARY 2022

**ISO 14998:2013(E) (Modified), Petroleum and natural gas
industries—Downhole equipment—Completion accessories**



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 ensure 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 Specification 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.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the publisher, API Publishing Services, 200 Massachusetts Avenue, NW, Washington, DC 20001.

Copyright © 2016 American Petroleum Institute

API 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.

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

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

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, NW, 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, NW, Washington, DC 20001.

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

Contents

- 1 Scope 1
- 2 Normative References 1
- 3 Terms and Definitions 2
- 4 Acronyms and Abbreviations 9
- 5 Functional Specification 9
 - 5.1 General 9
 - 5.2 Functional Type Description 9
 - 5.3 Well Parameters 10
 - 5.4 Operational Parameters 11
 - 5.5 Environmental Compatibility 11
 - 5.6 Compatibility with Related Well Equipment 12
 - 5.7 Design Validation 12
 - 5.8 Quality Control 12
- 6 Technical Specification 12
 - 6.1 General 12
 - 6.2 Technical Characteristics 12
 - 6.3 Design Requirements 12
 - 6.4 Design Verification 15
 - 6.5 Design Validation 18
 - 6.6 Design Changes 21
 - 6.7 Design Validation Scaling 22
- 7 Supplier/Manufacturer Requirements 22
 - 7.1 General 22
 - 7.2 Documentation and Data Control 22
 - 7.3 Product Identification 25
 - 7.4 Quality Requirements 25
- 8 Redress and Repair 32
- 9 Shipment and Storage 33
- Annex A (normative) Validation Test Requirements for All Products 34
- Annex B (normative) Validation Test Requirements for Disconnect/(Re)Connect Functionality 39
- Annex C (normative) Validation Test Requirements for Tubing-movement Functionality 43
- Annex D (normative) Validation Test Requirements for Opening/Closing a Port Functionality 46
- Annex E (normative) Identification and Explanation of Deviations 50
- Annex F (informative) API Monogram Program: Use of the API Monogram by Licensees 59
- Bibliography 63
- Figures
 - 1 Example of a Rated Performance Envelope 15
 - 2 Example of Shear Device Options 16
 - 3 Example of an Elliptical Envelope 17

Contents

Tables

1	Summary of Design Validation Grades	19
2	Design Validation Grade Hierarchy	19
3	Required Test Annex(es)	20
4	Summary of Quality Requirements	26
5	Summary of Assembly Verification Requirements	31
B.1	Minimum (Re)connected Requirements Based on Completion Accessory	39
C.1	Minimum Stroke Distance Requirements Based on Completion Accessory	43
D.1	Minimum Cycle and Unloading Pressure Requirements Based on Completion Accessory	46

ISO 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives.

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

Introduction

This International Standard has been developed by users/purchasers and suppliers/manufacturers of completion accessories intended for use in the petroleum and natural gas industry worldwide. This International Standard is intended to give requirements and information to both parties in the selection, manufacture, testing, and use of completion accessories. Further, this International Standard addresses supplier/manufacturer requirements that set the minimum requirements with which suppliers/manufacturers shall comply to claim conformity with this International Standard.

This International Standard has been structured to allow for grades of increased requirements both in quality control and design validation. These variations allow the user/purchaser to select the grade required for a specific application for a chosen accessory.

The three quality grades provide the user/purchaser the choice of requirements to meet a specific preference or application. Quality grade Q3 is the minimum grade of quality offered by this product standard. Quality grade Q2 provides additional inspection and verification steps, and quality grade Q1 is the highest grade provided. Additional quality requirements may be specified by the user/purchaser as supplemental requirements.

Seven standard design validation grades (V0 to V6) provide the user/purchaser the choice of requirements to meet a specific preference or application. Design validation grade V6 is the minimum grade and represents equipment where the validation method has been defined by the supplier/manufacturer. The complexity and severity of the validation testing increases as the grade number decreases.

Users of this International Standard should be aware that requirements above those outlined in this International Standard may be needed for individual applications. This International Standard is not intended to inhibit a supplier/manufacturer from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the supplier/manufacturer should identify any variations from this International Standard.

Specification for Completion Accessories

1 Scope

This International Standard provides requirements and guidelines for completion accessories, as defined herein, for use in the petroleum and natural gas industry. This International Standard provides requirements for the functional specification and technical specifications, including design, design verification and validation, materials, documentation and data control, quality requirements, redress, repair, shipment, and storage. This International Standard covers the pressure-containing, nonpressure-containing, load-bearing, disconnect/reconnect, tubing-movement, and opening-a-port functionalities of completion accessories.

Products covered under another API or international specification are not included. Also not included are other products such as liner/tubing hangers, downhole well test tools, inflow control devices, surface-controlled downhole chokes, downhole artificial lift equipment, control lines and fittings, and all functionalities relating to electronics or fiber optics. This International Standard does not cover the connections to the well conduit. Installation, application, and operation of these products are outside the scope of this International Standard.

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 5CRA, *Specification for Corrosion Resistant Alloy Seamless Tubes for Use as Casing, Tubing and Coupling Stock*

API Specification 5CT, *Specification for Casing and Tubing*

API Technical Report 5C3, *Technical Report on Equations and Calculations for Casing, Tubing, and Line Pipe Used as Casing or Tubing; and Performance Properties Tables for Casing and Tubing*

API Specification 20A, *Carbon Steel, Alloy Steel, Stainless Steel, and Nickel Base Alloy Castings for Use in the Petroleum and Natural Gas Industry*

ANSI ¹/NACE MR0175 ²/ISO 15156 ³ (all parts), *Petroleum and natural gas industries—Materials for use in H₂S-containing environments in oil and gas production*

ASME Boiler and Pressure Vessel Code (BPVC) ⁴, *Section IX: Welding and Brazing Qualification*

ASNT SNT-TC-1A ⁵, *Personnel Qualification and Certification in Nondestructive Testing*

ISO 2859-1, *Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3601-1, *Fluid power systems—O-rings—Part 1: Inside diameters, cross-sections, tolerances and designation codes*

¹ American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, New York 10036, www.ansi.org.

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

³ International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org.

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

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

ISO 3601-3, *Fluid power systems—O-rings—Part 3: Quality acceptance criteria*

ISO 9000, *Quality management systems—Fundamentals and vocabulary*

ISO 9712, *Non-destructive testing—Qualification and certification of NDT personnel*

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in ISO 9000 and the following apply.

3.1

anchor

Completion accessory designed to disconnect or reconnect the tubing by attaching to a designed receptacle.

3.2

assembly

Product comprised of more than one component.

3.3

blast joint

Completion accessory with anti-erosion provision on the outside diameter (OD).

3.4

casing

Pipe extending from the surface and intended to line the walls of a drilled well.

3.5

chemical injection mandrel

Completion accessory with provision to attach conduit(s) for injection of chemicals.

3.6

completion accessory

Equipment that forms an integral part of the tubing and is not covered by any other API/ISO downhole equipment standards.

3.7

component

Individual part of an assembly.

3.8

conduit

Casing, tubing, or liner, either metallic or nonmetallic.

3.9

crossover

See **tubing adapter**.

3.10

design validation

Process of proving a design by testing to demonstrate conformity of the product to design requirements.

(Source: API Q1:2013, Section 3.1.9.)

3.11

design verification

Process of examining the result of design and development output to determine conformity with specified requirements.

(Source: API Q1:2013, Section 3.1.10.)

3.12**disconnect load**

Load at which a completion accessory is designed to disconnect.

3.13**downhole artificial lift equipment**

Equipment integral to the conduit that provides additional energy to the production fluids.

3.14**downhole well test tools**

Downhole tools temporarily set in place for the purpose of evaluating the production potential of the chosen formation.

3.15**drift diameter**

Inside diameter (ID) of a completion accessory, expressed as the OD of the drift bar utilized during assembly inspection, as outlined in 7.4.11.

3.16**end connection**

Thread or other mechanism connecting the completion accessory to the conduit.

3.17**entry (reentry) guide**

Completion accessory used to facilitate entry/reentry.

3.18**expansion (travel) joint**

Completion accessory that facilitates tubing movement.

3.19**exposed component**

Flow-wetted component, internally wetted component, and/or component contacted by well fluid in the annulus.

3.20**extension (spacer) sub**

Completion accessory that has threaded connections on each end and maintains pressure integrity.

NOTE May include items such as mill-out extension or sand control extension.

3.21**fill valve**

Completion accessory with provision to open and/or close a port in the tubing to allow passage of fluids between the ID of the tubing and the annulus, or vice versa.

3.22**filter mandrel**

Completion accessory with provision to attach or include control line filter(s).

NOTE Unported designs of filter mandrels are covered by definition of mandrel.

3.23**flow coupling**

Completion accessory with anti-erosion provision on the ID.

3.24**flow-wetted component**

Component that comes in direct contact with the dynamic movement of well fluids in the flow stream.

3.25**gauge mandrel**

Completion accessory with provision to attach permanent monitoring devices.

3.26**gauge OD**

Maximum specified product OD.

3.27**grade**

Category or rank given to different requirements for quality or design validation.

3.28**indicator**

Completion accessory that provides an identification of linear position within a conduit typically used in sand control operations.

3.29**inflow control device**

Device that regulates the flow into the production conduit.

3.30**internally wetted component**

Flow-wetted component and any component out of the flow stream, but contacted by well fluids through a port or other passage to the flow-wetted area.

3.31**job lot**

Batch of material or components that have undergone the same process or series of processes.

3.32**job lot traceable**

The ability for parts to be identified as originating from a job lot that identifies the included heat(s).

3.33**liner**

Pipe not extending from the surface and intended to line the walls of a drilled well.

3.34**liner (tubing) hanger**

Mechanical device used for transferring the load of an inner liner (tubing) to the casing below the wellhead.

3.35**locator**

Completion accessory with provision to disconnect or reconnect the tubing to a designed receptacle.

3.36**mandrel**

Component(s) of a completion accessory that contains an end connection and provides a conduit through the completion accessory.

3.37**manufacturing**

Process and actions performed by an equipment supplier/manufacture that are necessary to provide finished component(s), assembly(ies), and related documentation, that fulfill the requests of the user/purchaser, and that 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), assemblies, and related documentation are surrendered to a transportation provider.

3.38**mill-out extension**

Completion accessory used below a packer to facilitate removal by milling.

NOTE May be pressure-containing or nonpressure-containing.

3.39**nonconformance**

Nonfulfillment of a specified requirement.

3.40**nonsealing space out joint**

Completion accessory with provision to accommodate tubing movement used to adjust tubing lengths, but without provision to hold pressure.

3.41**number of disconnects [(re)connects]**

Number of times a completion accessory can be disconnected [(re)connected] and perform its intended function.

3.42**number of strokes**

Maximum number of times a completion accessory can be moved through its stroke length and perform its intended function.

3.43**one-piece mandrel**

Mandrel or completion accessory that does not have leak paths excluding the end connections.

NOTE Welded one-piece mandrels are outside the scope of this definition.

3.44**on-off tool**

Completion accessory with provision to disconnect or reconnect the tubing.

3.45**open/close cycle**

Opening and then closing a port.

3.46**packer**

Mechanical device with a packing element, not installed in a designed receptacle, used for blocking fluid (liquid or gas) communication through the annular space between conduits by sealing off the space between them.

3.47**parting tool**

Completion accessory that is designed to separate control line(s) or cable(s) to facilitate tubing removal.

3.48**perforated sub**

Completion accessory that contains flow ports for the passage of fluids from the ID of the tubing to the annulus, or vice versa.

3.49**performance envelope**

Graph that illustrates the combined ratings of differential pressure and axial loads.

3.50**polished bore receptacle**

Completion accessory with designed receptacle used to disconnect or reconnect the tubing by accepting a locator, seal assembly, or similar device.

3.51**port flow area**

Area for the passage of fluids from the ID of the tubing to the annulus, or vice versa.

3.52**pressure reversal**

Change in direction of the pressure differential.

3.53**qualified person**

Individual with documented abilities gained through training or experience or both as measured against established requirements, such as standards or tests that enable the individual to perform a required function effectively.

3.54**(re)connect temperature**

Temperature at which the completion accessory can be (re)connected and performs its intended function.

3.55**redress**

Replacement of components on a completion accessory after original manufacture.

3.56**repair**

Redress and remanufacture of the completion accessory to restore it to the original functionality.

3.57**sand control expansion joint**

Completion accessory that facilitates tubing movement in a sand control completion.

3.58**sand control sliding sleeve**

Sand control completion accessory that has a sleeve designed to open or close communication.

3.59**seal assembly**

Completion accessory that seals in a designed receptacle.

3.60**seal bore extension**

Completion accessory designed to accept a seal assembly or similar device.

3.61**sealing device**

Device providing a barrier to the passage of liquid and/or gas across the interface between two components.

3.62**sealing space out joint**

Completion accessory with provision to accommodate tubing movement used to adjust tubing lengths with a provision to hold pressure.

3.63**shear device**

Component designed to disconnect one time at a predetermined load.

3.64**shear-out safety joint**

Completion accessory with provision to disconnect the tubing at a predetermined load through use of a shear device.

3.65**sliding sleeve**

Completion accessory that is activated to open or close communication between the tubing and annulus by moving a sleeve.

3.66**stroke**

Movement from one end of the stroke length to the other end.

3.67**stroke distance**

Cumulative distance determined by the number of rated strokes multiplied by the stroke length.

3.68**stroke length**

Distance between the fully collapsed position and fully expanded position for a completion accessory with provision to accommodate tubing movement.

3.69**substantive design change**

Change to the design, identified by the supplier/manufacturer, that may affect the performance of the product in the intended service condition.

3.70**surface-controlled downhole choke**

Surface-controlled downhole device used to restrict flow.

3.71**surface-controlled sliding sleeve**

Tubing-mounted device that is activated to open or close communication between the tubing and annulus by moving a sleeve without thru-tubing intervention.

3.72**telescoping swivel sub**

Completion accessory with provision to rotate and accommodate tubing movement.

3.73**temperature cycle range**

Specified range of temperature fluctuation over which the product is designed to operate.

NOTE The temperature cycle range is applicable anywhere within the product's temperature range.

3.74**temperature range**

Specified range of temperature at which the product is designed to operate.

3.75**temporary pressure-retaining device**

Completion accessory that provides tubing pressure integrity and the capability of providing temporary tubing pressure retention and release, when defined conditions are met.

3.76**tubing**

Pipe placed within a well to serve as a production or injection conduit.

3.77**tubing adapter**

Completion accessory that connects two different end connections.

3.78**tubing seal receptacle**

Completion accessory with designed receptacle used for one or more disconnect(s) or reconnect(s) of the tubing by accepting a locator, seal assembly, or similar device.

3.79**tubing size**

Nominal tubing OD as specified in API 5CT/API 5CRA.

3.80**Type 1 component or weld**

Component or weld that isolates pressure and/or may be loaded in tension as the result of axial loads on the completion accessory during run-in, activation, in situ, or retrieval.

3.81**Type 2 component or weld**

Component or weld that does not meet the criteria of a Type 1 component.

3.82**unloader sub**

Completion accessory with provision to open and/or close a port in the tubing to allow passage of fluids between the ID of the tubing and the annulus, or vice versa.

3.83**unloading pressure**

Maximum differential pressure across a completion accessory at the time of disconnect, or port opening, at which the completion accessory can perform its intended function.

3.84**y-block**

Completion accessory that connects one tubing string from above to two tubing strings below, or vice versa.

4 Acronyms and Abbreviations

AQL	acceptance quality limit
COC	certificate of compliance
FEA	finite element analysis
ID	inside diameter
MTR	material test report
NDE	nondestructive examination
OD	outside diameter
QC	quality control
UNS	unified numbering system

5 Functional Specification**5.1 General**

The user/purchaser shall prepare a functional specification to order products that conform to this International Standard and specify the following requirements and operating conditions, as applicable, and/or identify the supplier/manufacturer's specific product. These requirements and operating conditions may be conveyed by means of a dimensional drawing, datasheet, or other suitable documentation.

5.2 Functional Type Description

The user/purchaser shall specify the following functional type(s) based on the product's intended function(s).

- Nonpressure-containing, such as:
 - entry (reentry) guide (3.17);
 - nonsealing space out joint (3.40);
 - mill-out extension (3.38);
 - perforated sub (3.48).
- Pressure-containing, such as:
 - blast joint (3.3);
 - chemical injection mandrel (3.5);
 - crossover (3.9) or tubing adapter (3.77);
 - extension (spacer) sub (3.20);
 - filter mandrel (3.22);
 - flow coupling (3.23);
 - gauge mandrel (3.25);

- indicator (3.28);
- parting tool (3.47);
- temporary pressure-retaining device (3.75);
- tubing adapter (3.77);
- y-block (3.84).
- Disconnect/(re)connect, such as:
 - anchor (3.1);
 - locator (3.35);
 - on-off tool (3.44);
 - shear-out safety joint (3.64);
 - tubing seal receptacle (3.78).
- Tubing movement, such as:
 - expansion (travel) joint (3.18);
 - polished bore receptacle (3.50);
 - sand control expansion joint (3.57);
 - seal assembly (3.59);
 - seal bore extension (3.60);
 - sealing space out joint (3.62);
 - telescoping swivel sub (3.72).
- Open a port in the conduit; such as:
 - fill valve (3.21);
 - sand control sliding sleeve (3.58);
 - sliding sleeve (3.65);
 - unloader sub (3.82).

NOTE This is a representative sample of completion accessories and is not meant to be all inclusive of products covered in this International Standard. Completion accessories may have multiple functionalities; they have been listed here only as examples of products that have the listed functionality.

5.3 Well Parameters

The user/purchaser shall specify, as applicable, the following well parameters:

- dimensions, material, and grade of the casing and tubing;
- end connections;
- well angle from the vertical;
- deviations and restrictions product must pass through;

- configuration of tubing (single or multiple strings) and other lines (electrical/hydraulic/fiber-optic) that must pass through or bypass the completion accessory;
- relationship of the completion accessory with other well devices/tubing/casing by means of a well schematic drawing, if applicable;
- expected minimum and maximum values of production/injection pressures, pressure differentials, temperatures, changes in temperatures, and flow rates;
- any other relevant well parameter(s).

5.4 Operational Parameters

The user/purchaser shall specify, as applicable, any of the following operational parameters:

- installation method, including conveyance method;
- activation method and number of times activated or manipulated;
- setting depth;
- retrieving method;
- anticipated loading conditions, including combined loading (pressure, tension/compression) and torque, applied to the completion accessory prior to and during activation, during use, and during retrieving;
- expected activation temperature and anticipated temperature cycle during well operations and completion processes;
- size, type, and configuration of devices to be run through or over the completion accessory;
- any other relevant operational parameter(s).

5.5 Environmental Compatibility

5.5.1 General

If the user/purchaser has access to the corrosion property data of the operating environment based on historical data and/or research, they shall state to the manufacturer which material(s) has the ability to perform as required within the corrosion environment per the requirements of 5.5.3 as applicable. Otherwise, material compatibility shall be specified according to 5.5.2.

5.5.2 Well Environment

The user/purchaser should identify the density, chemical/physical composition, and the condition of the fluid and/or its components, including solid (sand production, scale, etc.), liquid, and/or gas, to which the completion accessory is exposed during its expected life cycle.

5.5.3 Material Designation

If the user/purchaser chooses to specify materials, requirements for compliance with ANSI/NACE MR0175/ISO 15156 shall be stated.

Material selection may be made for a group of components using the following designations:

- flow-wetted components (3.24);
- internally wetted components (3.30);
- exposed components (3.19).

5.6 Compatibility with Related Well Equipment

The user/purchaser shall identify, as applicable, the following:

- top and bottom tubular connection(s), the material, including any supplemental and/or annex requirements required in an internationally recognized standard such as API 5CT or API 5CRA, and dimensions of the connections to the conduit(s);
- internal receptacle profile(s), bore dimensions(s), OD, ID, and the respective locations;
- size, type, and configuration of other products and conduits to be used in connection with this product.

5.7 Design Validation

The user/purchaser shall specify the required design validation grade. This International Standard provides seven design validation grades (V6 to V0), as defined in 6.5.1 and the annexes. The selected design validation grade applies to all applicable validation testing per Annex A through Annex D.

5.8 Quality Control

The user/purchaser shall specify the required quality grade. This International Standard provides three grades (Q3, Q2, and Q1) of quality control (QC), as defined in 7.4.1.

6 Technical Specification

6.1 General

The supplier/manufacturer shall prepare a technical specification that conforms to the requirements defined in the functional specification. If the technical specification does not fully meet the functional requirements, the supplier/manufacturer shall identify the differences to the user/purchaser. The supplier/manufacturer shall also provide to the user/purchaser the product datasheet defined in 7.2.3.

6.2 Technical Characteristics

The following criteria shall be met:

- the product shall perform in accordance with the functional specification during installation, activation, operation, and retrieval;
- where applicable, the product shall not compromise well intervention operations.

6.3 Design Requirements

6.3.1 General

Products conforming to this International Standard shall be manufactured to drawings and specifications that are substantially the same as those of the same size, type, and model of product that was validated.

6.3.2 Design Documentation

Design of products manufactured to this International Standard shall include documentation of those designs. This documentation shall include, as applicable, design requirements, assumptions, analysis methods, comparison with previous designs or operating history of similar products, calculations, manufacturing drawings and specifications, design reviews, and/or physical testing results (such as design validation testing). The supplier/manufacturer shall identify each component as either a Type 1 (3.80) or Type 2 (3.81).

6.3.3 Materials

6.3.3.1 General

Materials (both metallic and nonmetallic), and/or compliance with ANSI/NACE MR0175/ISO 15156, shall be stated by the supplier/manufacture and shall be suitable for the environment specified in the functional specification. The manufacturer shall have documented specifications for all materials, and all materials used shall comply with the manufacturer's documented specifications.

The user/purchaser may specify materials for the specific use and corrosion environment in the functional specification. Should the manufacturer propose to use another material, the manufacturer shall state that this material has performance characteristics suitable for all parameters specified in the well and production/injection parameters.

Material substitution is a temporary change to a bill of material for a validated item that does not decrease the performance capabilities of the product. Material substitutions from those materials used in the validation-tested completion accessory products are allowed without validation testing as long as they meet the requirements of 6.4. The manufacturer's selection criteria for these substitutions shall be documented, and the substituted material shall conform to the design, functional, and technical requirements of this International Standard.

Material substitutions require approval by a qualified person from the supplier/manufacture and the supporting documentation incorporated into the manufacturing records.

6.3.3.2 Metals

6.3.3.2.1 Specifications

The manufacturer's specifications shall define:

- a) unified numbering system (UNS) number or chemical-composition limits;
- b) heat treatment conditions;
- c) mechanical property limits:
 - 1) tensile strength;
 - 2) yield strength;
 - 3) elongation;
 - 4) hardness.

6.3.3.2.2 Mechanical Property Verification

When required by the user/purchaser, the mechanical properties for Type 1 metal components shall be verified by tests conducted on a material sample produced from the same heat of material. The material sample shall experience the same heat treatment process as the component it qualifies.

6.3.3.3 Nonmetals

The manufacturer's documented specifications for nonmetallic compounds shall include handling, storage, and labelling requirements, including the cure date, batch number, compound identification, and shelf life appropriate to each compound, and shall define those characteristics critical to the performance of the material, such as:

- a) compound type;
- b) mechanical properties:
 - 1) tensile strength (at break),
 - 2) elongation (at break),
 - 3) tensile modulus (at 50 % or 100 %, as applicable);
- c) compression set;
- d) durometer hardness.

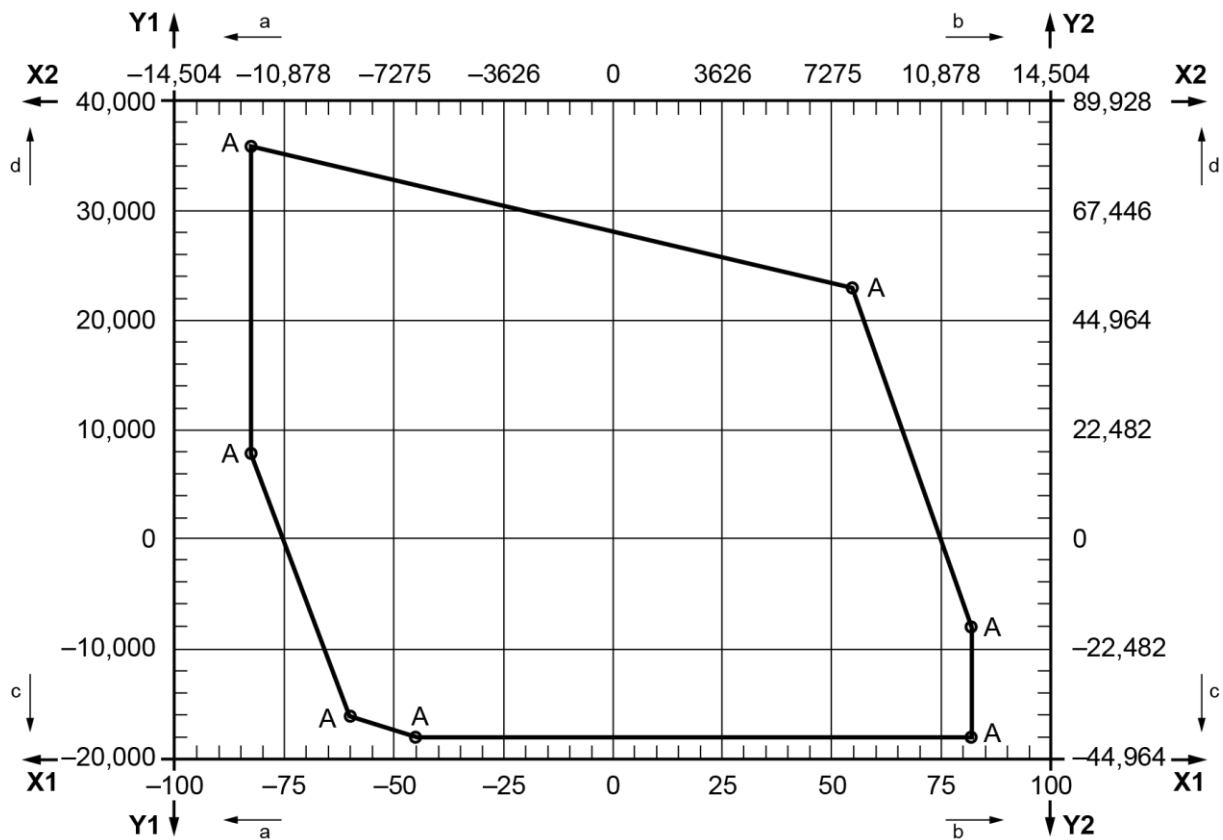
6.3.4 Performance Rating

The supplier/manufacturer shall state the performance ratings for the following: pressure, temperature, axial loads, disconnect, (re)connect, and tubing movement, as applicable for the products. For completion accessories validated to grades V4 through V0, a rated performance envelope is also required.

An example envelope is illustrated in Figure 1. The area within the boundaries defines the rated performance envelope. The lines forming the boundary of the envelope are defined as the maximum operational limits for the products. Metal mechanical properties within the temperature range shall be considered when determining performance ratings.

Rated performance envelopes shall meet the following criteria.

- The rated performance envelope shall represent the supplier/manufacturer's maximum ratings.
- Products with IDs shall be represented with the ID not plugged unless specified with the envelope.
- The ratings of the end connections shall not be included.
- Axis and sign convention shall be oriented as shown in Figure 1.
- More than one graph may be displayed with the envelope if a legend is included for explanation. For example, various shear device options can be displayed, as shown in Figure 2.
- Some products (typically of a single component) may be represented by a curved or elliptical envelope as shown below in Figure 3. Points on the curved envelope within any quadrant where the maximum magnitude of either the load or pressure value exceeds the magnitude of the load or pressure value at the axes are considered maximum operational limit points of the tool as shown in Figure 3.
- The product(s) covered by the envelope shall be specified with the envelope. If the envelope covers two or more products that are used together downhole, then this shall be stated on the envelope.



Key

X1	pressure, expressed in megapascals	a	external
X2	pressure, expressed in pounds per square inch	b	internal
Y1	force, expressed in decanewtons	c	compression
Y2	force, expressed in pounds	d	tensile

NOTE Points labelled "A" are intersection points of two or more operational limits.

Figure 1—Example of a Rated Performance Envelope

6.4 Design Verification

6.4.1 General

Design verification shall be performed to ensure that each completion accessory design meets the supplier/manufacture's technical specifications, including all conveyance, operational, removal methods/tools, contingency, and all rated functionalities. Design verification includes activities such as design reviews, design calculations, comparison with similar designs and historical records of defined operating conditions. Verification results shall be approved by a qualified person, and records of the results shall become a portion of the design documentation.

6.4.2 Design Assumptions

The supplier/manufacture shall apply a design margin to each component and/or assembly using a documented methodology and practice. The documented design margins shall be utilized in the creation of component or assembly capabilities and/or ratings.