

Subsurface Safety Valve and Annular Safety Valve Equipment

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Contents

	Page
1 Scope.....	1
2 Normative References	1
3 Terms, Definitions, Acronyms, Abbreviations, and Symbols	4
3.1 Terms and Definitions	4
3.2 Acronyms, Abbreviations, and Symbols	10
4 Functional Specification	11
4.1 General	11
4.2 SSSV Functional Characteristics	12
4.3 Well Parameters	12
4.4 Operational Parameters	13
4.5 Environmental Compatibility	13
4.6 Compatibility with Related Well Equipment	14
4.7 Insert SSSV Considerations	14
4.8 User/Purchaser Grade Selection	14
5 Technical Specification	16
5.1 Technical Requirements	16
5.2 Technical Characteristics of SSSV	16
5.3 Design Criteria	16
5.4 Design Verification	21
5.5 Design Validation	25
5.6 Equipment Performance Ratings	32
5.7 Design Changes	32
5.8 Design Validation by Scaling for SSSVs	33
5.9 Functional Test.....	34
5.10 Alternate Technologies.....	34
5.11 Design Assessment	35
6 Supplier/Manufacturer Requirements	36
6.1 General	36
6.2 Documentation and Data Control	36
6.3 Product Identification	40
6.4 Quality Control	41
6.5 Functional Testing	50
6.6 Failure Reporting and Analysis	51
7 Repair/Redress	51
7.1 Repair	51
7.2 Redress	51
8 Storage and Preparation for Transport	51
Annex A (normative) Test Agency Requirements	53
Annex B (normative) Validation Testing Requirements	56
Annex C (normative) Functional Testing Requirements	84

Contents

	Page
Annex D (normative) Supplier/Manufacturer Validation Testing Requirements for Grades V2-R, V2, V3-R, and V3	93
Annex E (normative) Alternative Requirement for Closure Mechanism Minimal Leakage	96
Annex F (normative) Design Validation Requirements for Secondary Tools	97
Annex G (normative) Validation Grade V1 and V1-R Requirements.....	100
Annex H (normative) Verification and Validation Requirements for High-pressure, High-temperature Environment	112
Annex I (informative) Extended Sand Endurance Testing	121
Annex J (informative) Combined Loads Operational Test	126
Annex K (informative) Gas Slam Closure Testing	130
Annex L (normative) Dynamic Seal System Test.....	133
Annex M (normative) Rated Performance Envelope	135
Annex N (normative) Alternative Validation Test Requirements	137
Annex O (normative) Annular Safety Valves	163
Bibliography.....	177

Figures

B.1	Example of Characteristic Hydraulic Control Pressure Curve for SCSSVs	57
G.1	Example of an Operating Life Test Profile.....	101
M.1	Rated Performance Envelope Example.....	135
O.1	ASV in Open Condition	176
O.2	ASV in Closed Condition	176

Tables

1	Description of Validation Grades.....	15
2	Additional Tests.....	15
3	Design Validation Grade Coverage.....	26
4	Mechanical Properties	42
5	Maximum Defect Severity Levels for Castings	47
B.1	Test Agency SCSSV V3-R Steps	58
B.2	Test Agency SCSSV V2-R Steps	59
B.3	SCSSV Gas Flow Test.....	60

Contents

	Page
B.4 SCSSV Gas Flow Rates	61
B.5 TRSV Drift Test	62
B.6 WRSV Drift Test	63
B.7 SSSV Liquid Leakage Test	64
B.8 Unequalized Opening Test—SCSSV	64
B.9 Operating-pressure Test—SCSSV	65
B.10 Propane Test—SSSV	66
B.11 Nitrogen Leakage Test—SSSV	68
B.12 V3-R Water Flow Test—SCSSV	69
B.13 SCSSV Liquid Flow Rates	69
B.14 Controlled-temperature Test—SCSSV	71
B.15 Grade V2-R Slurry Flow Test—SCSSV	73
B.16 Grade V2-R Liquid Flow Rates	74
B.17 Test Agency SSCSV Grade V3-R Steps	74
B.18 Test Agency SSCSV V2-R Steps	75
B.19 Gas Closure Test—SSCSV	75
B.20 Liquid Closure Test—SSCSV	76
B.21 Propane Test—SSCSV	77
B.22 V3-R Liquid Flow Test—SSCSV	78
B.23 SSCSV Liquid Flow Rates	79
B.24 V2-R Slurry Flow Test—SSCSV	80
B.25 Test Agency SSISV Grade V3-R Steps	81
B.26 Gas Injection Test—SSISV	82
B.27 Liquid Injection Test—SSISV	82
B.28 V3-R Liquid Flow Test—SSISV	83
C.1 Functional Test Procedure—SCSSV	85
C.2 Functional Test Procedure—Velocity-type SSCSV	89
C.3 Functional Test Procedure—Tubing-Pressure-type SSCSV	90
C.4 Functional Test Procedure—SSISV	91
G.1 Operating Life Test at Minimum Rated Operating Temperature	102
G.2 Operating Life Test at Maximum Rated Operating Temperature with Intermediate Testing at Ambient Temperature	103
G.3 Operating Cycle Test at Maximum Operating Temperature	106
G.4 Hydraulic Control Line Chamber Evaluation	107
G.5 Closure Mechanism Differential Slam Open Test	108
G.6 Equalization Mechanism Endurance Test	110
H.1 Nonmetal Material Additional Specification Requirements	115
H.2 Elastomeric Material Additional Specification Requirements	115
H.3 Thermoplastic Material Additional Specification Requirements	116
I.1 Extended Sand Endurance Test	122
J.1 Combined Loads Operational Test	128
K.1 Gas Slam Closure Test	131
L.1 Dynamic Seal System Testing	134
N.1 Difference between Annex B and Annex N	137
N.2 SCSSV Gas Flow Rates	140
N.3 SCSSV Liquid Flow Rates	144
N.4 SSCSV Liquid Flow Rates	148
O.1 ASV Validation Grades	165
O.2 Opening Differential Unloading Validation Test—AFIA	167
O.3 Functional Test Procedure—ASV	172

Introduction

This specification has been developed by users/purchasers and suppliers/manufacturers, of subsurface safety valves intended for use in the petroleum and natural gas industry worldwide. This specification is intended to give requirements and information to both parties in the selection, manufacture, testing, and use of subsurface safety valves. Furthermore, this specification addresses the minimum requirements to claim conformity to this specification.

Users of this specification should be aware that requirements above those outlined in this specification may be needed for individual applications. This specification is not intended to inhibit a supplier/manufacture 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 specification and provide details.

The International System of Units (SI) is used in this specification; however, U.S. Customary (USC) or other units are also shown for reference.

The requirements for lock mandrels and landing nipples contained in prior editions of this specification are now included in API Specification 14L.

This specification has been structured with design validation grades of increased requirements allowing the user/purchaser to select the validation grade required for a specific application.

There are eight design validation grades for SSSVs and two design validation grades for ASVs to provide the user/purchaser the choice of requirements to meet a specific preference or application. New to the 13th edition are design validation grades V1-HR, V1-R, V2-R, and V3-R for SSSVs, and V4-A and V3-A for ASVs. Design validation grades V1-H, V1, V2, and V3 are for products with Test Agency Validation tests meeting requirements listed in [Annex N](#). V1-HR and V1-H are for high-pressure high-temperature (HPHT) applications with specific requirements listed in [Annex H](#). The complexity and severity of the validation testing increases as the grade number decreases. Quality requirements for the manufacture of prototypes and factory-produced SSSVs and ASVs are included, however the use of quality levels has not been deemed necessary due to the critical nature of the downhole safety valve.

Changes to this specification in 13th edition include but are not limited to:

- 1) New normative annex, [Annex N](#) for Test Agency Validation requirements performed prior to the 12th edition (previously Annex B in 11th edition);
- 2) New normative annex, [Annex O](#) for Annular Safety Valves, there are also some requirements for ASVs within the main body of the specification;
- 3) Validation grades V4-1 or V4-2 are no longer included as these were for products validated prior to the 12th edition;
- 4) For the additional validation grades V1-HR, V1-R, V2-R, V3-R, the suffix -R designates that the Test Agency Validation test meets the requirements of [Annex B](#) of this edition, and other required validation testing found in this specification. Validation grades without the suffix -R designates that the Test Agency Validation was performed prior to the 12th edition (previously Annex B in 11th edition) and meets the requirements of [Annex N](#) and other required validation testing found in this specification.

Subsurface Safety Valve and Annular Safety Valve Equipment

1 Scope

This specification provides the requirements for subsurface safety valves (SSSVs), annular safety valves (ASVs) and the secondary tools as defined herein necessary to operate the features included within them, including all components that establish tolerances and/or clearances that may affect performance or interchangeability of the SSSV or ASV components. It includes repair operations and the interface connections to control conduits and/or other equipment but does not cover the connections to the primary well conduit.

NOTE The SSSV and ASV are emergency fail-safe devices. The products covered within this specification are installed and operated to the requirements of API Recommended Practice 14B.

This specification does not cover installation, maintenance, control systems for SSSV or ASV, computer systems, and control conduits not integral to the downhole SSSV or ASV. Also not included are products covered under API 6A, API 11D1, API 14L, API 17C, API 19G, API 19AC, API 19V, and other products with API specifications.

This specification only covers ASVs which are surface controlled.

Repair activities for SSSVs, ASVs, and secondary tools, conducted after final manufacturing is complete and product is shipped are covered by this specification. Redress activities for SSSVs, ASVs, and secondary tools are addressed in API Recommended Practice 14B and are outside the scope of this specification.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

ANSI/ASQ Z1.4, *Sampling Procedures and Tables for Inspection*

ANSI/NACE MR 0175/ISO 15156¹ (all parts), *Petroleum and natural gas industries — Materials for use in H₂S-containing environments in oil and gas production*

API Manual of Petroleum Measurement Standards (MPMS), Chapter 10.4, *Determination of Water and/or Sediment in Crude Oil by the Centrifuge Method (Field Procedure)*

API Specification 5B, *Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*

API Specification 11D1, *Packers and Bridge Plugs, Fourth Edition*

API Recommended Practice 13B-1, *Recommended Practice for Field Testing Water-based Drilling Fluids*

API Recommended Practice 14B, *Design, Installation, Repair and Operation of Subsurface Safety Valve Systems*

API Specification 14L, *Specification for Lock Mandrels and Landing Nipples*

API Standard 17F, *Specification for Subsea Production Control Systems, Fourth Edition*

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

¹ NACE International, 15835 Park Ten Place, Houston, Texas 77084, www.nace.org.

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

ASME Boiler and Pressure Vessel Code (BPVC),² *Section V: Nondestructive examination*

ASME Boiler and Pressure Vessel Code (BPVC), *Section VIII; Division 1; UW-51: Radiographic Examination of Welded Joints*

ASME Boiler and Pressure Vessel Code (BPVC), *Section VIII, Division 2:2011: Alternative Rules—Rules for Construction of Pressure Vessels*

ASME Boiler and Pressure Vessel Code (BPVC), *Section VIII; Division 3:2011: Alternative Rules for Construction of High Pressure Vessels—Rules for Construction of Pressure Vessels*

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

ASTM A370,³ *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A388/A388M, *Standard Practice for Ultrasonic Examination of Heavy Steel Forgings*

ASTM D297: *Standard Test Methods for Rubber Products – Chemical Analysis*

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

ASTM D412, *Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension*

ASTM D624, *Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D785, *Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials*

ASTM D790, *Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*

ASTM D792, *Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*

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

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

ASTM D1708, *Standard Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens*

ASTM D2240, *Standard Test Methods for Rubber Property—Durometer Hardness*

ASTM D2990, *Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics*

ASTM E21, *Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials*

ASTM E94, *Standard Guide for Radiographic Examination*

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

³ ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.



ASTM E127, *Standard Practice for Fabrication and Control of Flat Bottomed Hole Ultrasonic Standard Reference Books*

ASTM E140, *Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness*

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

ASTM E186, *Standard Reference Radiographs for Heavy Walled [2 to 4 1/2 in. (51 to 114 mm)] Steel Castings*

ASTM E280, *Standard Reference Radiographs for Heavy Walled [4 1/2 to 12 in. (114 to 305 mm)] Steel Castings*

ASTM E446, *Standard Reference Radiographs for Steel Castings Up to 2 in. (50.8 mm) in Thickness*

ASTM E1444, *Standard Practice for Magnetic Particle Testing for Aerospace*

ASTM E3024, *Standard Practice for Magnetic Particle for General Industry*

ISO 34-2 ,⁴ *Rubber, vulcanized or thermoplastic—Determination of tear strength—Part 2: Small (Delft) Test Pieces*

ISO 48-2, *Rubber, vulcanized or thermoplastic—Determination of hardness Part 2: Hardness between 10 IRHD and 100 IRHD*

ISO 812, *Rubber, vulcanized or thermoplastic—Determination of low-temperature brittleness*

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 815-2, *Rubber, vulcanized or thermoplastic—Determination of compression set — Part 2: At low temperatures*

ISO 1432, *Rubber, vulcanized or thermoplastic—Determination of low-temperature stiffening (Gehman test)*

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, Fifth Edition*

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

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 6892-1, *Metallic materials—Tensile testing—Part 1: Method of test at room temperature*

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

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

⁴ International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland, www.iso.org.

ISO 23936-2:2011, *Petroleum, petrochemical and natural gas industries—Non-metallic materials in contact with media related to oil and gas production—Part 2: Elastomers*

SAE AMS 2750,⁵ (R) *Pyrometry*

3 Terms, Definitions, Acronyms, Abbreviations, and Symbols

3.1 Terms and Definitions

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

3.1.1

annular flow isolation assembly

AFIA

Device integral to the ASV which contains a closure mechanism which prevents uncontrolled annular flow when closed.

3.1.2

annular packer assembly

Device integral into the ASV with a packing element used for blocking fluid (liquid or gas) communication through the annular space between conduits by sealing the space between them.

NOTE The annular packer assembly can contain anchoring capabilities.

3.1.3

annular safety valve

ASV

A subsurface assembly comprised of an annular flow isolation assembly and annular packer assembly which prevents uncontrolled annular well flow when closed.

3.1.4

ASV rated working pressure

ASV RWP

The lesser of

- a) the annular packer assembly differential rating or,
- b) the differential rating of the annular flow isolation assembly with the valve closed.

NOTE The internal yield pressure rating of the annular flow isolation assembly can be different than the differential rating of the ASV with the valve closed.

3.1.5

by-pass flow area

The flow area which passes through the ASV closure mechanism and circumvents the packing element.

3.1.6

closure mechanism

Interconnected components with the primary function to shut off well flow.

NOTE The closure mechanism does not include common fasteners used to secure the mechanism.

⁵ SAE International (formerly the Society of Automotive Engineers), 400 Commonwealth Drive, Warrendale, Pennsylvania 15096-0001, www.sae.org.

3.1.7**compound**

Combination of constituent elements of the formulation of a nonmetallic material.

3.1.8**design acceptance criteria****DAC**

Defined limits placed on characteristics of materials, products, or services established by the organization, customer, and/or applicable specifications to achieve conformity to the product design.

3.1.9**design margin**

Ratio of the material yield stress divided by the actual design stress in a given component.

NOTE Design margins account for a level of reduced performance capability to compensate for uncertainties in the potential loading (applied stress) and the intrinsic variations in the mechanical properties such as yield strength, ultimate strength, endurance strength, and modulus of elasticity that have distribution about their mean values.

3.1.10**design validation**

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

NOTE Design validation can include one or more of the following (this is not an all-inclusive list):

- a) prototype tests,
- b) functional and/or operational tests of production products,
- c) tests specified by industry standards and/or regulatory requirements,
- d) field performance tests and reviews.

3.1.11**design verification**

Process of examining the result of a given design or development activity to determine conformity with specified requirements.

NOTE Design verification activities can include one or more of the following (this is not an all-inclusive list):

- a) confirming the accuracy of design results through the performance of alternative calculations,
- b) review of design output documents independent of activities of design and development,
- c) comparing new designs to similar proven designs.

3.1.12**dynamic seal system**

Components of a hydraulic SSSV actuator that function together to open and/or close the SSSV.

NOTE This typically includes the actuator piston, associated seals, backups, guide rings, and any other piston-related components, as well as the bore in which the piston operates.

3.1.13**end connection**

Thread or other mechanism providing equipment-to-tubular interface.

3.1.14**environment**

Set of conditions to which the product is exposed.

NOTE Conditions may include but are not limited to temperature, pressure, and fluid exposure.

3.1.15**failure**

Any condition of SSSV/ASV equipment that can prevent the equipment from performing to the functional requirements of this specification.

3.1.16**fail-safe device**

Device which, upon loss of the control signal, automatically shifts to a closed position.

3.1.17**fit**

Geometric relationship between parts.

NOTE This includes the tolerance criteria used during the design of a part and its mating parts, including seals.

3.1.18**function**

Operation of a product during service.

3.1.19**functional test**

Testing conducted to demonstrate that equipment satisfies operational performance requirements.

3.1.20**functionally equivalent component**

Component(s) in a scaled design that perform the same primary function as the component(s) in the validated base design.

3.1.21**heat treatment****heat treating**

Alternate steps of controlled heating and cooling of materials for the purpose of changing mechanical properties.

3.1.22**high-pressure, high-temperature equipment****HPHT**

Equipment assigned a pressure rating greater than 103.4 MPa (15,000 psig) or a temperature rating greater than 176.7 °C (350 °F).

NOTE Requirements for high-pressure, high-temperature (HPHT) equipment are included in [Annex H](#).

3.1.23**interchangeability**

Ability to replace one component/subassembly with another component/subassembly without any subsequent requirement to adjust or alter it or the mating components/subassemblies, while retaining conformance to the assembled product's performance.

3.1.24**lock mandrel**

Retention device used for flow control equipment or other equipment [API Specification 14L].

3.1.25**manufacturer**

Principal agent in the design, fabrication, and furnishing of equipment, who chooses to conform with this specification.

3.1.26**manufacturing**

Process and action performed by an equipment supplier/manufacturer that are necessary to provide finished component(s), assembly(ies), and related documentation that fulfil the requests of the user/purchaser and meet the standards of the supplier/manufacturer.

3.1.27**mass loss corrosion****weight loss corrosion (deprecated term)**

Loss of metal in areas exposed to fluids that contain water or brine and carbon dioxide (CO₂), oxygen (O₂), or other corrosive agents.

3.1.28**model**

SSSV/ASV equipment with unique components and operating characteristics that differentiate it from other SSSV/ASV equipment of the same type.

NOTE The same model can have any of a variety of end connections.

3.1.29**operating cycle**

Starting from either open or closed position, moving to the opposite position, and returning to the original position.

NOTE An example of an operating cycle may be the closure mechanism moving from fully closed to fully opened and returning back to fully closed.

3.1.30**operating life**

Expected period of time or number of operating cycles that the product shall function.

3.1.31**operating manual**

Publication issued by the supplier/manufacturer that contains detailed data and instructions related to the installation, operation, and maintenance of equipment.

3.1.32**operating parameters**

Inputs or conditions necessary to achieve an operating cycle.

NOTE An example of an operating parameter is the hydraulic pressure required to actuate the closure mechanism from the closed position to the open position.

3.1.33**orifice (bean)**

Designed restriction causing a pressure drop in velocity-type subsurface-controlled subsurface safety valves (SSCSVs).

3.1.34**packing element**

Seal on an annular packer assembly that blocks fluid communication by sealing on the ID of the casing or tubing.

3.1.35**profile**

Feature that is designed for the reception of a locking mechanism.

3.1.36**qualified person**

Individual or individuals with characteristics or 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.

3.1.37**ratcheting**

Progressive incremental inelastic deformation or strain that can occur in a component that is subjected to variations of mechanical stress, thermal stress, or both (thermal stress ratcheting is partly or wholly caused by thermal stress) [ASME *BPVC* Section VIII, Division 3].

3.1.38**rated working pressure****RWP**

The lesser of:

- a) the SSSV internal pressure rating, or
- b) the differential rating with the valve closed.

3.1.39**redress**

Any activity involving the replacement of qualified parts [cf. **repair** (see 3.1.40)].

NOTE The definition for qualified parts is provided in API Recommended Practice 14B.

3.1.40**repair**

Any activity beyond the scope of redress that includes disassembly, reassembly, and testing with or without the replacement of parts and may include machining, welding, heat treating, or other manufacturing operations that restore the equipment to its original performance [cf. redress (see 3.1.39)]. [API Recommended Practice 14B]

3.1.41**seal component**

Component or assembly preventing passage (i.e. communication) of liquid and/or gas, not including sealing devices.

NOTE Examples of seal components include O-rings, v-rings, t-seals, and metal seal rings.

3.1.42**sealing device**

Device preventing passage (i.e. communication) of liquid and/or gas across the interface between the lock mandrel or WRSV and the landing nipple or SSSV.

3.1.43**secondary tool**

Tools and other equipment used with SSSVs/ASVs to perform a secondary function(s) or provide another intended design function.

NOTE Secondary tools may include communication tools, exercise tools, permanent lock open, temporary lock open, and accessory tools.

3.1.44**size**

Relevant dimensional characteristics of the equipment as defined by the supplier/manufacturer.

3.1.45**sour service**

Exposure to oilfield environments that contain H_2S and can cause cracking of materials by the mechanisms addressed in ANSI/NACE MR0175.

NOTE Adapted from ANSI/NACE MR0175-1.

3.1.46**special feature**

Specific component or subassembly that provides a functional capability that is not validated during the validation test conducted in accordance with [Table 1](#).

NOTE Special features may include items such as ambient chambers, fluid charged chambers, equalization flow, lock open, exercise, communication devices, mechanisms that provide fail-safe activation, control fluid redirection features, or electronic sensing and control. This list of special features is not fully inclusive.

3.1.47**stress corrosion cracking**

Cracking of metal involving anodic processes of localized corrosion and tensile stress (residual and/or applied) in the presence of water and dissolved halides and/or H_2S .

NOTE Dissolved halide salts, H_2S , O_2 and/or other oxidants, and elevated temperature increase the susceptibility of metals to this mechanism of attack.

3.1.48**stress cracking**

A generic term to refer to either stress corrosion cracking (3.1.47), or sulfide stress cracking (3.1.55), or both within this specification.

3.1.49**stress relief**

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

3.1.50**subassembly**

Subordinate unit consisting of two or more components assembled for incorporation as an integral portion of a product that may be independently performance tested before its integration.

3.1.51**substantive design change**

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

3.1.52**subsurface-controlled subsurface safety valve****SSCSV**

SSSV actuated by the characteristics of the well.

NOTE These devices are usually actuated by the differential pressure through the SSSV (velocity-type) or by tubing pressure at the SSSV.

3.1.53**subsurface injection safety valve****SSISV**

SSSV that is opened by injected flow and used to prevent backflow.

NOTE These devices are usually actuated by the differential pressure through the subsurface injection safety valve (SSISV) (velocity-type) or by tubing pressure at the SSISV (tubing-pressure-type).

3.1.54**subsurface safety valve****SSSV**

Device whose design function is to prevent uncontrolled well flow through the tubing when closed.

NOTE SSSVs can be installed and retrieved by wireline or pump-down methods (wireline-retrievable) or be an integral part of the tubing string (tubing-retrievable).

3.1.55**sulfide stress cracking**

(SSC) Cracking of metal involving corrosion and tensile stress (residual and/or applied) in the presence of water and H₂S.

NOTE SSC is a form of hydrogen stress cracking and involves embrittlement of the metal by atomic hydrogen that is produced by acid corrosion on the metal surface. Hydrogen uptake is promoted in the presence of sulfides. The atomic hydrogen can diffuse into the metal, reduce ductility, and increase susceptibility to cracking. High strength metallic materials and hard weld zones are prone to SSC. [NACE MR0175/ISO 15156]

3.1.56**surface-controlled subsurface safety valve****SCSSV**

SSSV controlled from the surface by hydraulic, electrical, mechanical, or other means.

3.1.57**test agency**

Organization that meets the requirements of [Annex A](#) in this specification.

3.1.58**test section**

Test apparatus that contains the SSSV and provides for connection to a test facility's validation test apparatus.

3.1.59**type**

SSSV/ASV equipment with unique characteristics that differentiate it from other functionally similar SSSV/ASV equipment.

NOTE See [4.2](#) for various types of SSSV.

3.1.60**validation test**

Test performed to qualify a particular size, type, and model of equipment for a specific validation grade.

3.2 Acronyms, Abbreviations, and Symbols

AFIA	annular flow isolation assembly
ASV	annular safety valve
ASV RWP	annular safety valve rated working pressure
CAD	computer-aided design

CFD	computational fluid dynamics
COC	certificate of conformance
DAC	design acceptance criteria
FEA	finite element analysis
FMEA	failure modes and effects analysis
HPHT	high-pressure, high-temperature
ID	inner diameter
MTR	material test report
NDE	nondestructive examination
OD	outer diameter
QMS	quality management system
RGD	rapid gas decompression
RWP	rated working pressure
SCSSV	surface-controlled subsurface safety valve
SITP	shut-in tubing pressure
SSCSV	subsurface-controlled subsurface safety valve
SSISV	subsurface injection safety valve
SSSV	subsurface safety valve
TRSV	tubing-retrievable safety valve
WRSV	wireline-retrievable safety valve
L	length
t	thickness

4 Functional Specification

4.1 General

4.1.1 The user/purchaser should prepare a functional specification for ordering products that conform to this specification and specify the following requirements and operating conditions, as applicable, and/or identify the supplier's/manufacture's specific product. These requirements and operating conditions may be conveyed by means of a dimensional drawing, data sheet, or other suitable documentation. If not provided, the supplier/manufacture shall generate a functional specification.

4.1.2 Annular Safety Valves (ASVs) shall conform with the requirements in [Annex O](#).

NOTE The requirements of Sections 4 through 8 of this specification apply to ASVs only as indicated by [Annex O](#).

4.1.3 The functional specification shall specify the following, but not be limited to:

- a) suitability for service conditions, such as resistance to corrosion, corrosion-erosion, solid contaminant accumulation, and service temperatures;
- b) specified loads and characteristics including temporary test conditions, possible cyclical loading conditions and changes to those parameters over the operating life, thermal gradients, and external loadings.

NOTE For information on the investigation of load cycling, see ASME *BPVC* Section VIII, Division 3, Article KD-3 or Article KD-4.

- c) operating life requirements;
- d) applicable industry standards and/or regulatory requirements;
- e) possible combinations of various well design criteria (these may be in the form of a desired operating envelope for the product).

NOTE Guidance on developing a functional specification can be found in ISO 13879.

The user/purchaser may identify the supplier/manufacture's specific product along with any applicable functional or technical changes. In making this selection the user/purchaser can evaluate the requirements of [Section 4](#).

4.2 SSSV Functional Characteristics

The SSSV functional characteristics should include the following when applicable:

- a) type of SSSV control (e.g. surface-controlled, subsurface-controlled, injection-controlled);
- b) type of SSSV retrieval (e.g. tubing-retrievable, wireline-retrievable, coil-tubing-retrievable, through-flowline-retrievable)
- c) type of SSSV closing mechanism (e.g. ball, flapper);
- d) internal self-equalizing capability;
- e) temporary or permanent lock-open system;
- f) control fluid communication from the surface-controlled subsurface safety valve (SCSSV) to any other subsurface device (e.g. an insert SSSV);
- g) pump-through capability;
- h) any redundant/independent backup operating systems.

4.3 Well Parameters

The following characteristics should be specified in the functional specification as applicable:

- a) well location (land, platform, subsea);
- b) size, mass, grade, and material of the casing and tubing;
- c) water depth, setting depth (maximum required for application), and control system parameters [control fluid type/properties, supply pressure, supply line(s), and connection rating(s)];
- d) casing and/or tubing architecture, trajectory, deviations, maximum dog leg severity;
- e) restrictions through which the SSSV shall pass and restrictions/profiles through which the SSSV service tools/accessories shall pass;
- f) requirements for passage of additional lines (electrical, hydraulic), between the valve outer diameter (OD) and the casing inner diameter (ID);
- g) annulus fluid gradient;

- h) well type—injector and/or producer.

4.4 Operational Parameters

4.4.1 Required Parameters

The following parameters shall be included in the functional specification.

4.4.1.1 The rated working pressure (RWP) and the rated temperature range shall be specified for the SSSV.

4.4.1.2 The following conditions under which the SSSV will operate (flow conditions) and the conditions under which the valve closes (see API Recommended Practice 14B) shall be specified:

- a) loading conditions, including combined loading (pressures, tension/compression, torque, bending) and the corresponding temperature extremes anticipated to be applied to the valve;
- b) at valve setting depth, the minimum and maximum values of the production/injection pressures and temperatures at the anticipated flow rates;
- c) composition of the production/injection fluid (gas/oil/water) and density of each component.

4.4.2 Optional Parameters

The following operational parameters should be specified for the SSSV if applicable:

- a) control system parameters [such as actuation mechanism, control system type/properties, supply requirements, supply line(s) and connection rating(s), closed loop feedback];
- b) inclination at setting depth if any (true vertical depth, measured depth);
- c) maximum allowable pressure drop at maximum production flow rate through SSSV;
- d) well stimulation operations, including its parameters, such as acidizing (composition of the acid, pressure, temperature, acid flow rate, and the exposure time), as well as any other chemicals used during the stimulation;
- e) well cementing operations, including its parameters, such as cement types and volumes, spacers, plugs, pressure, and flow rates;
- f) sand consolidation and fracturing operations, including sand/proppant description, fluid flow rate, proppant/fluid ratio or sand/fluid ratio, chemical composition, pressure, and temperature;
- g) well servicing activities through the safety valve: size, type, and configuration of secondary tools or other devices to be run with or through the valve;
- h) injection rate range for SSISV.

4.5 Environmental Compatibility

The following should be included in the functional specification:

- a) Production/injection/annulus fluid chemical and physical composition, including solids (e.g. sand production, scale), to which the SSSV is exposed during its full operating life.
- b) In cases where the user/purchaser has access to corrosion-property historical data and/or research that is applicable to the functional specification, the user/purchaser should state to the supplier/manufacturer which materials have the ability to perform as required within the anticipated corrosion environment.

- c) The equipment user/purchaser should confirm that any material specified for use is satisfactory in the service environment. If the user/purchaser requires analysis for metals beyond conformance with NACE MR0175, then those fluids, contaminants, and testing/qualification requirements shall be specified in the functional specification. Likewise, for nonmetallics, if analysis is required beyond [5.3.3.3.2 a\)](#), the fluids, contaminants, and testing/qualification requirements shall be specified in the functional specification.

NOTE ANSI/NACE MR0175/ISO 15556 prescribes laboratory testing to determine a materials performance when exposed to H₂S. The standard uses the following environmental variables: the minimum in situ water pH, the maximum chloride concentration, the maximum partial pressure of H₂S in the gas phase, minimum and maximum temperatures, and the presence of solid elemental sulfur. It is important to consider both the immediate short-term environment and changes that can occur in the longer term, such as increases in the partial pressure of H₂S due to reservoir souring from water injection.

4.6 Compatibility with Related Well Equipment

The following information, as applicable, should be specified to provide compatibility of the SSSV and secondary tools with the related well equipment:

- a) SSSV size, type, material, and the configuration of the end connections (these connections are not included in the evaluation of combined loading);
- b) internal profile(s), sealing bore dimension(s), outside diameter, inside diameter, and their respective locations relative to the SSSV;
- c) intervention requirements;
- d) requirement(s) for passage of conduits (electrical/hydraulic) between valve OD and casing ID, this may include associated clamps/securing mechanism(s).

4.7 Insert SSSV Considerations

API Recommended Practice 14B addresses the installation of an insert SSSV assembly in a primary locked open tubing-retrievable safety valve (TRSV).

4.8 User/Purchaser Grade Selection

4.8.1 Validation Grade

The user/purchaser should specify the validation grade required for the SSSV from [Table 1](#).

NOTE In the validation grades, the suffix -R designates that the Test Agency Validation test meets the requirements of [Annex B](#), which has the same requirements as the 12th edition. Validation grades without the suffix -R designates that the Test Agency Validation was performed prior to the 12th edition and meets the requirements of [Annex N](#).

4.8.2 HPHT Requirements

SSSVs with a RWP greater than 103.4 MPa (15,000 psi) or a temperature rating greater than 176.7 °C (350 °F) (HPHT service) or when specified by the user/purchaser, shall conform to [Annex H](#).

4.8.3 Additional User/Purchaser Specified Requirements

4.8.3.1 The user/purchaser may select additional testing as detailed in [Annex E](#) and Annexes I through L as listed in [Table 2](#).

4.8.3.2 When specified by the user/purchaser, a rated performance envelope shall be provided according to [Annex M](#) for validation grades V3-R, V3, V2-R and V2.

4.8.3.3 When specified by the user/purchaser, an aging evaluation shall be conducted by the supplier/manufacturer [see [5.3.3.3.2 d\)](#)] on an elastomeric material.

4.8.3.4 When specified by the user/purchaser, a rapid gas decompression (RGD) evaluation shall be conducted by the supplier/manufacturer on an elastomeric material [see [5.3.3.3.2 e\)](#)].

Table 1—Description of Validation Grades

Validation Grade	Comments	Reference to Prior Edition
V3	Validation grade V3 (see 5.5.1 and 5.5.2) contains the validation test requirements specified in Annex N and additional supplier/manufacturer tests in Annex D . It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	
V3-R	Validation grade V3-R (see 5.5.1 and 5.5.3) contains the validation test requirements specified in Annex B and additional supplier/manufacturer tests in Annex D . It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	New to this edition
V2	Validation grade V2 (see 5.5.1 and 5.5.4) contains the validation test requirements specified in Annex N and additional supplier/manufacturer tests in Annex D . It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	
V2-R	Validation grade V2-R (see 5.5.1 and 5.5.5) contains the validation test requirements specified in Annex B and additional supplier/manufacturer tests in Annex D . It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	New to this edition
V1	Validation grade V1 (see 5.5.6) SSSVs meet all the requirements of Annex N in this edition of API 14A plus additional testing detailed in Annex G .	
V1-R	Validation grade V1-R (see 5.5.7) SSSVs meet all the requirements of Annex B in this edition of API 14A plus additional testing detailed in Annex G .	New to this edition
V1-H	Validation grade V1-H (see Annex H) SSSVs meet all the requirements of Annex N in this edition of API 14A plus additional testing detailed in Annex G , Annex J , and Annex L .	
V1-HR	Validation grade V1-HR (see Annex H) SSSVs meet all the requirements of Annex B in this edition of API 14A plus additional testing detailed in Annex G , Annex J , and Annex L .	New to this edition

Table 2—Additional Tests

Annex Identification	Annex Title	General Description of Content	Purpose
E	Alternative requirements for closure mechanism minimal leakage	Provides alternative leakage acceptance criteria for the functional test	Provides more stringent leak rate acceptance criteria
I	Extended sand endurance testing	Enhanced sand endurance testing	Evaluates the ability of the valve design to close and seal in sandy conditions
J	Combined loads operational test	Validation of closed end rated performance envelope limits	Confirms the ability of the SSSV to operate at the limits of the performance envelope
K	Gas slam closure testing	Testing requirements for high-rate slam closures	Evaluates closure of SSSV in increased flow rate gas wells
L	Dynamic seal system test	Testing requirements for primary dynamic seal systems at intermediate positions at static conditions	Evaluates gas sealing integrity of the dynamic seal system

5 Technical Specification

5.1 Technical Requirements

5.1.1 The supplier/manufacture shall prepare and provide to the user/purchaser the technical specification that demonstrates that the equipment meets the requirements of the functional specification.

5.1.2 An SSSV produced according to this specification shall be designed and manufactured under a quality management system (QMS) that conforms to API Specification Q1 or equivalent.

5.2 Technical Characteristics of SSSV

The following criteria shall be met:

- a) SSSV shall close and effectively shut in the flow when predefined conditions are met;
- b) SCSSV and SSISV shall close upon loss of operational signal;
- c) the SSSV shall be located and/or seal at the specified location and remain so until intentional intervention defines otherwise;
- d) the SSSV shall allow well-intervention operations (see [4.4.2](#));
- e) the SSSV and secondary tools shall conform to the functional specification and within the limitations defined in the product-specific operating manual and design criteria.

5.3 Design Criteria

5.3.1 General

5.3.1.1 SSSV designs shall permit prediction and repeatability of rates, pressures, or other conditions required for closure over the operating life of the product.

5.3.1.2 Secondary tool designs shall permit prediction and repeatability of the stated capabilities.

5.3.2 Design Requirements

5.3.2.1 Documentation of designs and design changes shall include methods, assumptions, formulas, calculations, and design requirements (see [6.2.1.2](#)). Design requirements shall include, but not be limited to, those criteria for size, test pressure, working pressure and operating parameters (such as pressure, current, voltage, flow rate), materials, environment (temperature limits, validation grade, chemicals), and other pertinent requirements upon which the design is based. Final design documentation shall be reviewed and verified by a qualified person other than the individual who created the original design.

5.3.2.2 Equipment conforming to this specification shall be manufactured to drawings and specifications that do not have any substantive design changes from those of the size, type, and model equipment that have passed the applicable validation tests.

5.3.2.3 The supplier/manufacture shall establish verified internal yield pressure, collapse pressure, tensile load strength, operating temperature range, control chamber pressure rating if applicable, and RWP, excluding end connections. The design shall consider the effects of pressure containment and pressure-induced loads. Specialized conditions such as testing with temporary test plugs shall also be identified and reviewed and addressed as necessary.

5.3.2.4 The supplier/manufacture shall identify the critically stressed components of the product and the mode of stress. The supplier/manufacture shall calculate the critical stress level in the identified component(s) based upon the worst-case loads in the design input requirements.

5.3.2.5 The minimum material condition and minimum material yield strength shall be used in the calculations. The calculations shall include consideration of the effects of temperature on material properties. Metal mechanical properties temperature derating shall be verified by a qualified person and in accordance with the following:

- a) industry recognized published data, or
- b) data established by the supplier/manufacture, or
- c) data provided by the material supplier.

NOTE ASME BPVC Section II, Part D contains temperature derated tensile strengths for many materials.

5.3.2.6 The following apply to supplier/manufacture-assembled equipment and replacement components or subassemblies:

- a) additive dimensional tolerances of components and subassemblies shall allow the equipment to perform as designed, without limitation, regardless of the date or batch of manufacture;
- b) for each unique assembly, the components or subassemblies shall be interchangeable among other batch lots of the same unique assembly and shall produce a product that continues to meet the design validation requirements and the technical specifications.

5.3.2.7 Requirements for lock mandrel profiles and SSSV sealing devices are contained within API Specification 14L unless otherwise specified within API Specification 14A. When the requirements of API Specification 14A are more stringent, they shall apply.

5.3.2.7.1 Lock mandrel profiles used within the SSSV shall conform with the requirements defined in API Specification 14L for design validation grade V2 for landing nipples.

5.3.2.7.2 Sealing devices used on SSSV products shall conform with the requirements defined in API Specification 14L for design, validation, and scaling.

NOTE Requirements for surface NDE on landing nipples was added to the 3rd edition of API Specification 14L.

5.3.2.8 When requested in the functional specification and accepted by the manufacturer, the supplier/manufacture shall provide to the user/purchaser the preventive and remedial recommendations to address the potential for accumulated contaminants such as scale, paraffin, asphaltenes, frac solids, or cement. These may include design features, operational constraints, remedial treatments, or regular maintenance requirements.

5.3.2.9 The user/purchaser may request one of the following:

- a) a method of clearing a valve stuck by contaminants;
- b) a method of minimizing asphaltene accumulations;
- c) the supplier/manufacture provide preventive equipment to minimize material accumulations.

Additionally, the user/purchaser may request the supplier/manufacture to provide methods to protect the SSSV when remedial operations are performed elsewhere in the well.

5.3.3 Materials

5.3.3.1 General

5.3.3.1.1 Materials shall be documented by the supplier/manufacture and shall be suitable for the functional specification. The supplier/manufacture shall have documented specifications for all materials. All materials used shall conform with the supplier/manufacture's design acceptance criteria that include chemical and mechanical property limits.

5.3.3.1.2 The user/purchaser may specify materials for the specific environment in the functional specification. If the supplier/manufacture proposes to use another material, the supplier/manufacture shall state that this material has performance characteristics suitable for all parameters specified in the well and production/injection parameters. This applies to metallic and nonmetallic components.

5.3.3.1.3 Material substitutions from those materials used in a validated product are allowed without further validation testing. The supplier/manufacture's selection criteria for these substitutions shall be documented and the substituted material shall conform to the design, functional, and technical requirements of this specification. Material substitutions require documented approval by a qualified person using the methods and practices used to accept the original material, and the supporting documentation shall be retained per [6.2.1.1](#). When requested, material substitutions shall be reported to the user/purchaser.

5.3.3.2 Metals

5.3.3.2.1 The supplier/manufacture's specifications for traceable components (see [6.4.5](#)) shall define those characteristics critical to the performance of the material, such as the following:

- a) chemical-composition limits;
- b) heat treatment process;
- c) melt practice (for nickel and titanium-based alloys);
- d) mechanical-property limits as applicable:
 - 1) tensile strength,
 - 2) yield strength,
 - 3) elongation,
 - 4) hardness.

NOTE 1 For some SSSV material-component combinations such as structural load bearing or pressure-containing components, the supplier/manufacture may require Charpy impact testing in addition to the above list of requirements.

NOTE 2 Wear resistant materials loaded primarily in compression typically do not have design requirements for yield strength, tensile strength, or elongation.

5.3.3.2.2 The mechanical properties specified in 5.3.3.2.1 d) for traceable components shall be determined by tests conducted on a representative sample (e.g. prolongation, sacrificial casting or a separate test piece removed prior to heat treatment).

5.3.3.2.3 The representative sample shall be from the same heat of material. For remelt materials the sample shall be from the same final remelt heat.

5.3.3.2.4 The material sample shall undergo the same thermomechanical processing as the raw material used to manufacture the component it qualifies.

5.3.3.2.5 When heat treatment is performed, the representative sample shall be heat treated with the component(s) that it qualifies.

5.3.3.2.6 The mechanical property results shall be documented in an approved material test report (MTR) (see [6.4.3.1](#)).

5.3.3.2.7 Each welded component shall be stress relieved as specified in the supplier/manufacturer's written specifications. In addition, carbon and low-alloy steel weldments on sour service SSSV equipment shall be stress relieved in accordance with ANSI/NACE MR0175-2.

5.3.3.2.8 Materials selected for use in mass loss corrosion or stress cracking environments shall conform to the supplier/manufacturer's documented procedure or as specified by the user/purchaser.

5.3.3.2.9 Metallic materials used in stress cracking environments shall conform to the metallurgical requirements of ANSI/NACE MR0175 (all parts).

5.3.3.2.10 Metallic sealing devices and seal components, with exception of the closure mechanism (see 3.1.6), shall also conform to the requirements of [5.3.3.3.1](#) and [5.3.3.3.2](#) a) through c).

5.3.3.3 Nonmetals

5.3.3.3.1 General

The supplier/manufacturer shall have documented procedures, including acceptance criteria, for evaluation or testing of seal materials or other nonmetals to the limits for which the equipment is rated.

NOTE SSSV serving as injection valves may require an evaluation of sealing properties of nonmetallics at low temperatures.

5.3.3.3.2 Sealing System Requirements

Seal components shall meet the following requirements:

- a) Chemical and environmental effects shall be considered for nonmetallic seal components to determine selection of the seal material.
- b) Verification or validation shall establish that the nonmetal seal component used is suitable for the specific configuration, environment, and application. The evaluations or tests shall provide compatibility with the technical and functional requirements and shall address, as applicable, mechanical loads, applied pressure, temperature range, design geometry, and sealing environment.
- c) Scaling of seal component validation results shall be documented and approved by a qualified person. A validation test conducted on a seal component with a designed cross-section size shall validate all seal component bore sizes of the same design cross-section size. Limitations on scaling of nonmetallic seal components are as follows:
 - 1) the allowable variation in size for the scaled seal component shall be within $\pm 5\%$ of the nominal cross-section thickness of the validated seal component design.
 - 2) the scaled seal component extrusion gap and tolerances shall not be greater than that allowed by the validated seal component design.
 - 3) the loading mode (including any support mechanisms) shall be identical for the scaled seal component and the validated seal component.

- 4) the critical stress levels of metallic components surrounding the scaled nonmetallic seal component stated as a percentage of material yield, shall not exceed those of the validated seal component design at the same conditions.
- 5) the stress calculation method(s) shall be identical for the scaled seal component and the validated seal component; and
- 6) the seal component material specification shall be identical for the scaled seal component and the validated seal component.

NOTE See [H.3.5.2](#) for additional scaling limitations for HPHT nonmetal seal components.

- d) If required by the user/purchaser, an aging evaluation at or above the maximum rated operating temperature of the SSSV shall be conducted by the supplier/manufacturer to evaluate the cumulative effects of an environment on an elastomeric material per ISO 23936-2, Clause 7.2, or in accordance with the supplier/ manufacturer's documented testing procedure conforming to an industry specification and agreed to by the user/purchaser. This evaluation may include the determination of an effective service life.
- e) If required by the user/purchaser, an RGD evaluation shall be conducted by the supplier/manufacturer on an elastomeric material per ISO 23936-2, Annex B. The acceptance criteria shall be a rating of 0 or 1 for the seal component cross section. Fluid composition, test temperatures, test pressures, and depressurization rate are to be agreed between the supplier/manufacturer and user/purchaser.

5.3.3.3.3 Bonding to Substrates

5.3.3.3.3.1 Nonmetallic seal components may be bonded to substrates for additional reinforcement or to perform other functions. If the bond of the nonmetallic to the substrate is critical to performance, the integrity of the bond shall be evaluated in the same manner as the performance of the seal component itself per the supplier/ manufacturer's defined methods and acceptance criteria.

5.3.3.3.3.2 Substrate metals shall conform to the requirements for metallic components; nonmetallic substrates shall conform to the requirements of [5.3.3.3.4](#).

NOTE ASTM D429 provides methods for adhesion testing.

5.3.3.3.4 Nonmetallic Components

The supplier/manufacturer shall have written specifications for nonmetallic components that shall include handling, packaging, storage, and labeling requirements, including the cure date for elastomers, batch number, material identification, and shelf life appropriate to each material, and shall define those characteristics critical to the performance of the material, such as the following:

- a) material type;
- b) mechanical properties, as a minimum:
 - 1) tensile strength (at break),
 - 2) elongation (at break),
 - 3) tensile modulus (at 50 % or 100 %, as applicable) (elastomers only);
- c) compression set (elastomers only);
- d) durometer hardness;
- e) specific gravity;

- f) yield strength (thermoplastics only);
- g) elongation at yield (thermoplastics only);
- h) Young's modulus (thermoplastics only).

5.4 Design Verification

5.4.1 General

5.4.1.1 Design verification shall be performed using documented procedures to verify that each SSSV and secondary tool design meets the supplier/manufacture's technical specifications and shall include activities such as design reviews, design calculations, physical tests, comparison with similar designs, and historical records of defined operating conditions.

5.4.1.2 Verification results shall be reviewed and approved by a qualified person and records of the review shall become a portion of the design documentation (see [6.2](#)).

5.4.2 Design Assumptions

5.4.2.1 The supplier/manufacture shall have a design margin for each component or assembly.

5.4.2.2 The performance of the component or product shall be established based upon the component or systems minimum material condition, minimum allowable yield strength at the maximum rated operating temperatures (including temperature cycles) and maximum operational loads.

5.4.3 Design Analysis

5.4.3.1 General

5.4.3.1.1 The equipment shall be analyzed to determine the performance limits.

5.4.3.1.2 The performance limits of the assembly shall be determined by the component of the design with the lowest design margin.

5.4.3.1.3 The design shall consider all operational loading conditions defined in the functional specification as well as all functional test loads ([Annex C](#)).

5.4.3.1.4 One of the design analysis methods in [5.4.3.2](#) shall be used to determine the maximum state of stress of a component.

5.4.3.2 Design Analysis Methods

5.4.3.2.1 Distortion Energy Theory

5.4.3.2.1.1 The distortion energy theory, also known as the von Mises yield criterion, may be used for design calculations for pressure-containing components.

NOTE The distortion energy theory predicts a combined stress that will exceed the material's minimum yield strength; this is also commonly known as von Mises stress. This theory determines a combined stress at a point from the given principal stresses. The von Mises stress predicts failure when the total amount of distortion in a differential cube of material is equivalent to the distortion experienced by the same cube when loaded by a uniaxial force to the yield point.

5.4.3.2.1.2 Rules for the consideration of discontinuities and stress concentrations are beyond the scope of this method and this specification. However, the basic pressure-vessel wall thickness may be sized by combining triaxial stresses based on hydrostatic test pressure and limited by the following criterion:

$$S_E \leq S_Y$$

where

S_E is the maximum allowable equivalent stress at the most highly stressed distance into the pressure vessel wall, computed by the distortion energy theory method;

S_Y is the material-specified minimum yield strength.

5.4.3.2.2 Triaxial Yield Equations

API 5C3, Annex A, provides equations that may be used to derive the triaxial yield of a cylinder.

5.4.3.2.3 Finite Element Analysis

5.4.3.2.3.1 Finite element analysis (FEA) is a design verification methodology that may be used to predict equipment performance for complex geometry and/or complex loading where conventional verification methodologies are considered incomplete by the design engineer. FEA shall include the following information (as applicable) to enable verification of the results:

- a) description of the numerical method used, including name and version of computer software;
- b) geometry details:
 - 1) computer-aided design (CAD) format,
 - 2) simplified model for symmetry or full 3D model,
 - 3) element type,
 - 4) part dimensions that result in the highest state of stress;
- c) loading conditions:
 - 1) type (pressure, force, moment),
 - 2) magnitude and system of units,
 - 3) region of application (point, surface);
- d) boundary conditions:
 - 1) symmetry planes,
 - 2) spatial or displacement constraints,
 - 3) contacts (rigid, frictionless);
- e) material properties at temperature:
 - 1) modulus of elasticity;
 - 2) Poisson's ratio;
 - 3) yield strength;
 - 4) tensile strength;

- 5) material nonlinearity model (true stress, true strain curve; cyclic true stress, true strain curve);
- f) numerical analysis procedure:
 - 1) static,
 - 2) dynamic,
 - 3) buckling,
 - 4) harmonic,
 - 5) fatigue,
 - 6) fracture,
 - 7) geometrically linear or nonlinear;
- g) graphical display of results:
 - 1) stress contour plot,
 - 2) deformation plot;
- h) validation of numerical model:
 - 1) mesh sensitivity review,
 - 2) comparison with experimental data or analytical calculation;
- i) summary report:
 - 1) numerical analysis results, showing the acceptance criteria used to meet the design requirements,
 - 2) evidence of review and verification by a qualified person other than the individual who created the original design.

5.4.3.2.3.2 The FEA study shall be documented and electronically archived such that the study can be reevaluated at a later date. The data to archive shall include inputs, outputs, and a summary report of the FEA study.

5.4.3.3 Computational Fluid Dynamics

5.4.3.3.1 Computational fluid dynamics (CFD) is a design verification methodology that may be used to predict SSSV equipment performance under flowing conditions, such as erosion, slam closure, or flow assurance considerations.

CFD shall include the following information (as applicable) to enable verification of the results:

- a) description, name, and version of computer software;
- b) geometry details:
 - 1) CAD format,
 - 2) simplified model with reduced features, symmetrical 2D model, full 3D model,

- 3) model dimensions.
- c) boundary conditions:
 - 1) inlet and outlet geometry, diameter, length,
 - 2) symmetry planes,
 - 3) inlet or outlet mass flow rate or velocity,
 - 4) static pressure,
 - 5) backpressure.
- d) fluid model and properties at simulated temperature:
 - 1) laminar, turbulent (K-epsilon, shear-stress transport),
 - 2) nominal viscosity for Newtonian fluid or viscosity model for non-Newtonian fluid,
 - 3) compressibility,
 - 4) single or multiphase flow,
 - 5) density.
- e) numerical analysis procedure:
 - 1) steady state,
 - 2) dynamic or transient,
 - 3) erosion estimation,
 - 4) heat transfer.
- f) graphical display of results:
 - 1) velocity (contour plot, vector map),
 - 2) pressure change contour plot,
 - 3) streamlines of flow patterns and recirculation,
 - 4) areas of interest (identification of fast-impinging velocities and impact angle, vortices).
- g) validation of numerical model:
 - 1) mesh sensitivity review,
 - 2) convergence of iterative calculations,
 - 3) comparison with experimental data.
- h) summary report:
 - 1) numerical analysis results, showing the acceptance criteria used to meet the design requirements.

- 2) evidence of review and verification by a qualified person other than the individual who created the original design.

5.4.3.3.2 The CFD study shall be documented and electronically archived such that the study could be re-evaluated at a later date. The data to archive shall include the input files (problem files), output files (result files), and a summary report of the CFD study.

5.4.4 Rated Performance Envelope

A rated performance envelope as specified in [Annex M](#) shall be prepared for TRSVs validated to V1, V1-R, V1-H or V1-HR. For other validation grades, a rated performance envelope shall be prepared when requested in the functional specification.

5.4.5 Insert SSSV Considerations

For TRSVs with insert valve capability, the supplier/manufacturer shall conduct an analysis of the maximum control line pressure capability when communication is established between the primary and insert valves.

NOTE API Recommended Practice 14B contains information regarding insert SSSV.

5.5 Design Validation

5.5.1 General

5.5.1.1 The objectives of the validation testing requirements of this subsection are to qualify SSSV equipment for specific validation grades. SSSV equipment of each size, type, and model shall be validated in accordance with the requirements for the specific validation grade per [Annex B](#) or [Annex N](#) and this subsection.

NOTE The validation testing requirements in this specification are not represented as well conditions.

5.5.1.2 When the SSSV includes a landing nipple or a landing nipple profile, the supplier/manufacturer shall identify the size, type, and model of compatible mating lock mandrel(s). Validation of the landing nipple or landing nipple profile shall meet the requirements of API 14L V2 or as specified by the user/purchaser.

5.5.1.3 When the SSSV includes a lock mandrel, the supplier/manufacturer shall identify the size, type, and model of compatible mating landing nipple or profile and maintain design validation records of successful validation testing of the lock mandrel(s) and landing nipple or profile combinations integral to the SSSV. Validation of the lock mandrel shall meet the requirements of API 14L V1 or as specified by the user/purchaser.

5.5.1.4 The identification and ratings of the lock mandrel/landing nipple combinations shall be documented in the lock mandrel operations manual.

5.5.1.5 When the SSSV includes a landing nipple or a landing nipple profile supplied by another supplier/manufacturer, proof of validation shall be provided in the form of a certificate of conformance (COC).

NOTE Previous editions of API Specification 14A used the terminology design verification in lieu of design validation.

5.5.1.6 With mutual consent between the test agency and the supplier/manufacturer, higher flow rates than those stipulated in [Annex B](#) or [Annex N](#) may be applied and used for all flow tests.

5.5.1.7 Products qualified to higher grades of design validation shall be considered qualified for the lower grades of design validation in accordance with [Table 3](#).

Table 3—Design Validation Grade Coverage

Validation Grade	Grades Covered
V1-HR	V1-HR, V1-H, V1-R, V1, V2-R, V2, V3-R, V3
V1-R	V1-R, V1, V2-R, V2, V3-R, V3
V2-R	V2-R, V2, V3-R, V3
V3-R	V3-R, V3
V1-H	V1-H, V1, V2, V3
V1	V1, V2, V3
V2	V2, V3
V3	V3

5.5.2 Validation Grade V3

5.5.2.1 Validation grade V3 SCSSVs shall pass the test agency-conducted tests specified in [N.2.2](#) and the supplier/manufacture-specified tests in [Annex D](#). The Alternative Validation Test (N.1) shall have a validation test date prior to the effective date of this specification.

5.5.2.2 Validation grade V3 SSCSVs shall pass the test agency-conducted tests specified in [N.13](#), Step 1 through Step 9) and the supplier/manufacture-specified tests in [Annex D](#). The Alternative Validation Test (N.13) shall have a validation test date prior to the effective date of this specification.

5.5.2.3 The body joints in a V3 TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meet or exceed the current functional and performance requirements.

5.5.3 Validation Grade V3-R

5.5.3.1 Validation grade V3-R SCSSVs shall pass the test agency-conducted tests specified in [Table B.1](#) and the supplier/manufacture specified tests in [Annex D](#).

5.5.3.2 Validation grade V3-R SSCSVs shall pass the test agency-conducted tests specified in [Table B.17](#).

5.5.3.3 Validation grade V3-R SSISVs shall pass the test agency-conducted tests specified in [Table B.25](#) and the supplier/manufacture specified tests in [Annex D](#).

5.5.3.4 The body joints in a V3-R TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meet or exceed the current functional and performance requirements.

5.5.4 Validation Grade V2

5.5.4.1 Validation grade V2 SCSSVs shall pass the test agency-conducted tests specified in [N.2.2](#) and [N.2.3](#) and the supplier/manufacture-specified tests in [Annex D](#). The alternative validation test (N.1) shall have a validation test date prior to the effective date of this specification.

5.5.4.2 Validation grade V2 SSCSVs shall pass the test agency-conducted tests specified in [N.13](#) and the supplier/manufacture-specified tests in [Annex D](#). The alternative validation test (N.13) shall have a validation test date prior to the effective date of this specification.

5.5.4.3 The body joints in a V2 TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meet or exceed the current functional and performance requirements.

5.5.4.4 Validation grade V2 does not apply to SSISVs.

5.5.5 Validation Grade V2-R

5.5.5.1 Validation grade V2-R SCSSVs shall pass the test agency-conducted tests specified in [Table B.1](#) and [Table B.2](#) and the supplier/manufacture specified tests in [Annex D](#).

5.5.5.2 Validation grade V2-R SSCSVs shall pass the test agency-conducted tests specified in [Table B.17](#) and [Table B.18](#).

5.5.5.3 The body joints in a V2-R TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meet or exceed the current functional and performance requirements.

5.5.5.4 Validation grade V2-R does not apply to SSISVs.

5.5.6 Validation Grade V1

5.5.6.1 Validation grade V1 SCSSVs shall pass the tests specified in [Annex G](#) with the test agency test per [N.2.2](#) and [N.2.3](#).

5.5.6.2 The body joints in a V1 TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meets or exceeds the current functional and performance requirements.

5.5.6.3 Validation grade V1 does not apply to SSCSVs or SSISVs.

5.5.7 Validation Grade V1-R

5.5.7.1 Validation grade V1-R SCSSVs shall pass the tests specified in [Annex G](#) with the test agency test per [Table B.1](#) and [Table B.2](#).

5.5.7.2 The body joints in a V1-R TRSV shall be evaluated to verify that the body joints meet the functional and performance requirements. The evaluation may include design analysis, testing, or history of successful use in the field under conditions that meets or exceeds the current functional and performance requirements.

5.5.7.3 Validation grade V1-R does not apply to SSCSVs or SSISVs.

5.5.8 Validation Grade V1-H and V1-HR

5.5.8.1 SSSVs for use in an HPHT environment shall be validated according to the requirements of [Section H.3.4](#)

5.5.9 Additional Validation Testing

5.5.9.1 Additional validation testing selected by the user/purchaser shall be performed according to requirements of the applicable annexes (see [4.8.3](#)) and [5.5.16](#). In [Annex D](#) and [Annex L](#), the validation testing may be performed using fixtures that have equivalent fits, clearances, and loads as the affected portion of the SSSV.

5.5.9.2 The performance of informative annex testing when selected by the user/purchaser or supplier/manufacture can be combined or embedded into other validation testing or performed as standalone testing, except these additional tests may not be combined with the testing requirements of [Annex B](#) or [Annex N](#).

5.5.9.3 Where the informative annexes are combined and/or embedded with other validation testing procedures, the additions shall not cause any of the test steps or acceptance criteria to be reduced in scope or intent; the criteria may be made more stringent.

5.5.9.4 The additional testing shall be conducted in a sequence that does not invalidate the results of the [Annex D](#), [Annex G](#), or [Annex H](#) tests when performed without the additions. The new testing procedures, their justifications and the testing results shall be approved by a qualified person and become a portion of the product's design documentation.

5.5.10 User/Purchaser Specified Validation Testing

If the user/purchaser requires performance capabilities that are not validated by testing per this specification, the supplier/manufacture shall conduct the validation tests in conformance with the requirements of [5.5.16](#).

NOTE User/purchaser specified validation testing may include items such as erosion testing, debris tolerance, vibration testing, or cement-through capability.

5.5.11 Secondary Tool Validation

Secondary tools and systems designs shall be validated to their rated limits in conformance with the requirements of [Annex F](#).

5.5.12 Special Feature Validation

5.5.12.1 The supplier/manufacture shall identify, in design documentation, all special features included in the product design that are not validated by design validation testing per this specification.

5.5.12.2 Special features shall be validated by the supplier/manufacture to their rated limits to documented procedures including acceptance criteria and with the design validation records approved by a qualified person other than the individual who created the original design.

5.5.12.3 Special feature validation may include test results, operational histories, and evaluations.

5.5.12.4 Special feature validation for V1 and V1-R SSSV shall be by validation testing (see [G.6](#)).

5.5.12.5 The supplier/manufacture's design validation records shall include the design requirements, test procedures, test results, or evaluations of special features.

5.5.12.6 The supplier/manufacture shall identify those special features that shall be included in the functional testing.

5.5.13 Validation of Alternate Technologies

SSSVs with alternate technologies shall undergo design validation in conformance with [5.10.2](#).

5.5.14 Validation Test performed by a Test Agency (see [Annex B](#) or [Annex N](#))

5.5.14.1 General

5.5.14.1.1 Prior to shipping the SSSV to the test agency, the supplier/manufacture shall functionally test the SSSV in conformance with [Annex C](#).

5.5.14.1.2 Any repairs to the SSSV after passing the functional test shall require a repeat of the functional test.

5.5.14.1.3 The supplier/manufacture shall provide the test agency with an SSSV of the latest design revision, one operating manual, records of functional testing, and associated documentation for the size, type, and model for the design validation level and working pressure desired in the validation test.

5.5.14.1.4 The supplier/manufacture shall furnish any equipment not furnished by the test agency to accommodate installation of a particular SSSV in the test facility or to accomplish the validation test.

5.5.14.1.5 If a particular SSSV has design or operational features that are incompatible with the test facility and test procedures required by this specification, the supplier/manufacture shall advise the test agency as to the nature of the incompatibility and shall request and fully describe on the test application, or attachments thereto, any equipment or procedures required to test the SSSV. In addition, the following shall apply:

5.5.14.1.5.1 Responsibility for furnishing, installing, and testing this equipment shall be by agreement between the test agency and the supplier/manufacture.

5.5.14.1.5.2 The supplier/manufacture shall identify the proposed revised test steps/conditions and technically justify the revision(s) as no less stringent than the original test requirements.

5.5.14.1.5.3 The supplier/manufacture shall include the justification of any changes to the validation tests in the product's design documentation.

5.5.14.1.5.4 The supplier/manufacture and test agency shall be responsible for assuring that such equipment or procedures are not less stringent than this specification.

5.5.14.1.6 If alternate technology is used in SSSVs (see [5.10](#)), the supplier/manufacture shall present a schematic and an example of the system for the operation of the test valve.

5.5.14.1.7 Documentation of alternative technology design and quality parameters shall be provided to satisfy all operational, testing, repeatability, and safety controls for conformance to the requirements of this specification and the requirements of the test agency.

5.5.14.2 Validation Test Application

The supplier/manufacture shall supply a validation test application to the test agency with the following information as applicable:

- a) identification of product supplier/manufacture (company name, location/address, pertinent department, contact name and phone numbers);
- b) if retest, reference to previous test number;
- c) the test application shall include a statement verifying a successful functional test and all hardware supplied for the test;
- d) environmental controls requirements;
- e) equipment identification requirements:
 - 1) equipment type: SCSSV, SSCSV, SSISV,
 - 2) TRSV or wireline-retrievable safety valve (WRSV),
 - 3) model designation or other identification by supplier/manufacture,
 - 4) unique serial number,
 - 5) nominal tubing size,
 - 6) RWP,
 - 7) end connection type,
 - 8) test section length,

- 9) drift bar identifier and dimensions,
 - 10) drift sleeve identifier and dimensions (if WRSV).
 - 11) additionally, for SCSSV equipment:
 - i) minimum specified ID,
 - ii) maximum specified OD (for WRSV),
 - iii) maximum hydraulic control line pressure (greater than valve bore pressure and/or absolute maximum),
 - iv) maximum unequalized opening pressure;
 - 12) maximum gas pressure-relieving (bleed-down) rate,
 - 13) additionally, for SSCSV equipment, the closing parameters (fluid velocity, pressure, design closing flow rate, as appropriate),
 - 14) additionally, for SSISV equipment, the opening parameters (fluid velocity, pressure differential, as appropriate),
 - 15) additionally for alternate technologies (see [5.10](#)):
 - i) control system requirements and limitations,
 - ii) operations for activation or position controls,
 - iii) retained system pressures and limitations including safety precautions.
- f) The following procedures and special requirements shall be stated:
- 1) validation level to be tested,
 - 2) nonstandard equipment required for testing,
 - 3) deviations to the test facility procedures.

5.5.14.3 Post-test Requirements

5.5.14.3.1 In the case of validation test nonconformance, the supplier/manufacture shall be responsible for determining the cause of the nonconformance.

5.5.14.3.2 The test agency shall cooperate with the supplier/manufacture to determine whether the nonconformance was product or test agency related.

5.5.14.3.3 If the nonconformance is determined to be product-related, the nonconformance becomes a test failure; if the nonconformance is determined to be test agency related, the supplier/manufacture and test agency shall determine a course of action on the validation test process for the specific valve that is not less stringent than the validation testing requirements of this specification.

5.5.14.3.4 The test agency shall document the testing nonconformance on the test data forms.

5.5.14.3.5 If a particular size, type, and model of SSSV fails the validation test, that SSSV and any other SSSV of the same basic design and materials of construction shall not be submitted for retest until the supplier/manufacture has determined and documented the justification for retest.

5.5.14.3.6 The supplier/manufacture shall conduct this analysis and document the results, including any corrective action taken. Such information need not be submitted to the test agency and shall be placed in the supplier/manufacture's validation test file for that SSSV before the SSSV is submitted for retest.

5.5.14.3.7 If an SSSV fails the validation test and is subsequently repaired, it shall be functionally tested per [Annex C](#) prior to resubmitting for validation testing.

5.5.14.3.8 The supplier/manufacture shall maintain design validation records on each validation test including any retests that may have been required to qualify SSSV equipment. These records shall be retained by the supplier/manufacture for a period of 20 years after such SSSV equipment is discontinued from the supplier/manufacture's product line.

5.5.14.3.9 Pre-test and post-test dimensional verification of functionally critical dimensions defined by the supplier/manufacture shall be conducted and documented by the supplier/manufacture. Dimensions shall meet established acceptance criteria.

5.5.15 Test Agency Requirements

Test agencies shall meet the requirements of [Annex A](#).

5.5.16 Validation Testing Performed by a Supplier/Manufacturer

5.5.16.1 General

Validation tests conducted by the supplier/manufacture to the requirements of [4.8.3](#) or Annexes D, F, G, H, I, J, K, or L shall meet the requirements of [5.5.16](#). Each product tested shall pass all requirements within the limits specified, to the defined acceptance criteria, and with documentation and approval of the results.

5.5.16.2 Personnel

Preparation, testing, and approval of results shall be conducted by qualified personnel.

5.5.16.3 Procedures

The supplier/manufacture shall develop procedures for conducting the validation tests.

5.5.16.4 Measuring and Monitoring Equipment

5.5.16.4.1 Measuring and monitoring equipment used during the validation process shall be calibrated in accordance with the requirements of [6.4.6.2](#).

5.5.16.4.2 All pressures are defined as gauge unless otherwise specified and shall be recorded on time-based equipment.

5.5.16.5 Test Report

A test report shall be prepared and approved by qualified personnel and shall be retained as part of the design validation records for the product (see [6.2.1.2](#)). The report shall indicate the following information as a minimum:

- a) a description of the tested item which may include size, type, model, part number, and serial number;
- b) test facility name and location;
- c) date(s) of validation testing conducted;
- d) procedures used;

- e) records demonstrating conformance to the established procedures including acceptance criteria;

NOTE Records may be electronic or hardcopy.

- f) additional information required by the applicable annex describing the testing;
- g) summary of results including a discussion whether or not the test was successful;
- h) approvals and date of the report.

5.6 Equipment Performance Ratings

5.6.1 The supplier/manufacture shall determine and state the equipment-specific performance ratings on the shipping report as required by [6.2.2.2](#). Where a rated performance envelope is requested or required, the supplier/manufacture shall provide the rated performance envelope per [Annex M](#).

5.6.2 For secondary tools and special features, the supplier/manufacture shall determine and state the specific performance ratings in the operating manual.

5.7 Design Changes

5.7.1 Evaluation

5.7.1.1 The supplier/manufacture shall evaluate design changes to determine whether they are substantive (see 3.1.51) or non-substantive; this evaluation shall include as a minimum:

- a) stress levels of the replaced or changed components or subassemblies relative to the base design;
- b) interchangeability of the changed components or subassemblies relative to the base design;
- c) functional or operational changes including interaction with secondary and contingency tools.

5.7.1.2 Design changes shall conform to the design assumptions (see [5.4.2](#)) and design analysis (see [5.4.3](#)) methods that were applied to the base component or assembly and shall conform to the requirements of [5.3.2](#) and [5.4](#).

5.7.1.3 Evaluation results and justifications as a non-substantive design change shall be approved by a qualified person (see 3.1.36) other than the person performing them, and records of the results shall become a portion of the design documentation (see [6.2.1.2](#)).

5.7.2 Substantive Design Change

5.7.2.1 All design changes shall be documented and reviewed against the design verification and design validation to determine if the change is a substantive design change (see 3.1.51). A design that undergoes a substantive design change becomes a new design requiring design verification (see [5.4](#)) and design validation (see [5.5](#)); however, scaling is allowed in accordance with [5.8](#).

5.7.2.2 Design validation for changes to components or subassemblies may be done by validation testing only the component or subassembly rather than the entire assembly. The test(s) shall simulate the operating conditions that would be present if the entire assembly were tested.

5.7.2.3 The supplier/manufacture shall document the detailed test results and analysis that demonstrate that the component or subassembly test adequately simulates the required loading conditions.

5.7.3 Design Changes Requiring User/Purchaser Notification

If the supplier/manufacture determines that a design change to the SSSV and/or secondary tool reduces the specified performance of the product or has a negative impact on the operation of existing SSSVs or secondary tools, the supplier/manufacture shall supply written notification to the user/purchaser. This notification shall include a summary of performance changes and recommended disposition of all affected equipment.

NOTE An example of a design change requiring notification would be a change in calculation methodology that results in a lower rated working pressure.

5.8 Design Validation by Scaling for SSSVs

5.8.1 General

Scaling may be used to validate SSSVs of the same nominal size, type, and model by reference to a successfully validation tested product (base design) in accordance with the requirements and limitations of [5.8.2](#) and [5.8.3](#).

NOTE 1 For validation grade V1-H and V1-HR SSSV, refer to [H.3.5](#) for additional scaling requirements.

NOTE 2 For secondary tools, refer to [Annex F](#) for scaling requirements and limitations.

5.8.2 Evaluation of Scaled Design

5.8.2.1 Establish Design Margin

5.8.2.1.1 The supplier/manufacture shall identify the critically stressed components of the base design and establish the minimum design margins within those components at the maximum rated conditions and the specific mode of stress.

5.8.2.1.2 All design considerations and design margins applied to the base design and its components shall be applied to a scaled design.

5.8.2.1.3 The supplier/manufacture shall identify the critically stressed functionally equivalent components (see 3.1.20) between the two designs.

5.8.2.1.4 The supplier/manufacture shall establish the minimum design margins in the functionally equivalent components within the scaled design. The minimum acceptable material condition, minimum acceptable material yield strengths, and maximum and minimum temperature effects on material properties shall be used.

5.8.2.2 Design Margin Comparison

5.8.2.2.1 The evaluation of the scaled design shall include comparison of the calculated minimum design margins and these margins shall not be less than minimum design margins of the functionally equivalent components of the base design.

5.8.2.2.2 The mode of stress and same method of calculation(s)/evaluation(s) shall be applied to the identified components of both product designs.

5.8.2.2.3 Adjustments to material thickness or yield strengths shall not negatively impact minimum design margins. The scaled product shall be evaluated by the supplier/manufacture to verify that it will meet the requirements of the validation tests.

5.8.2.3 Documentation

Documentation of the design scaling activities, including design verification, evaluation, and justification, shall be included in the product's design documentation (see [6.2.1.2](#)).

5.8.3 Limitations of Scaling

Scaling is allowed to validate a product with the following limitations:

- a) scaling shall not be used to validate products with higher RWP (3.1.38) or a temperature range that exceeds upper and lower limits of the base design;
- b) the RWP shall not be derated by more than 50 % of the base design;
- c) the scaled valve shall not have more dynamic leak paths in either the closure mechanism or control system integral to the SSSV than the base design;
- d) A valve with equalizing features shall not be scaled from a valve with non-equalizing features.

NOTE For limitations on scaling of nonmetallic materials, see [5.3.3.3.2](#).

5.9 Functional Test

Equipment shall be designed to meet the requirements of the functional test (see [6.5](#)). The supplier/manufacture shall identify all special features which shall be included in the functional testing.

5.10 Alternate Technologies

5.10.1 General

5.10.1.1 The following requirements apply to all SSSVs with operating technologies other than a single direct hydraulic operating control system integral to the SSSV and without integral pressure assist mechanisms.

NOTE Alternate-technology SSSVs include designs such as but not limited to pressure charged systems, multiple hydraulic systems, indirect connection of the operator to the closure opening device, electric/electronically operated/induced activators, and control systems that include electrical and electronic signaling systems.

5.10.1.2 Alternate-technology designs shall conform to the requirements included in [Sections 4, 5, 6, 7, and 8](#), and Annexes B, C, or N of this specification. The performance of the validation requirements of the validation grade (see [Table 1](#)) and any additional testing (see [Table 2](#)) shall be completed to the defined acceptance criteria.

5.10.2 Design Validation

5.10.2.1 Alternate-technology SSSV designs shall undergo validation testing, as specified for the selected design validation grade.

5.10.2.2 Non-through-bore SSSV designs may be exempted from the internal drifting requirements when a suitable method to evaluate the closure mechanism full opening is specified in the supplier/manufacture's procedures.

5.10.2.3 Alternate-technology SSSV actuation systems shall demonstrate repeatability of operations requirements. Operations shall conform to measurable criteria as a replacement for the measurement and review of the conventional operating pressure traces defined in the validation testing procedures.

5.10.2.4 Alternate-technology SSSV actuation systems shall conform to supplier/manufacture defined integrity (other than hydraulic, such as electromagnetic signal interference) evaluations that demonstrate the system's response at the points defined in the validation testing procedures. Integrity validation of the actuation system shall be performed to measurable criteria as a replacement for the hydraulic control pressure evaluations in the validation testing procedures.

5.10.2.5 Supplier/manufacture procedures that include acceptance criteria shall be prepared and conformed to during the validation testing.

5.10.3 Operating Manual

The supplier/manufacture shall provide an operating manual that includes the following information as a minimum, in addition to the applicable requirements of [6.2.2.3](#):

- a) the full operational capabilities of the SSSV, required for validation testing and when it is installed;
- b) the control system capabilities and criteria required to facilitate those operations;
- c) the means provided to identify the fully open and fully closed positions of the SSSV;
- d) the requirements for monitoring the status of the installed SSSV;
- e) all special skills/tools/products necessary for the installation and performance of the SSSV;
- f) the necessary technical requirements for the control conduit, conduit connections, supporting clamps, special skills, and training required to install and/or operate the SSSV in the validation testing and permanent installation environments.

5.10.4 Functional Test Requirements

Functional testing of SSSVs with alternate technology shall be performed to the requirements of [6.5](#). Variations to the functional test requirements shall be limited to those defined in [5.10.2](#) as they are applied to the functional testing.

5.10.5 Reports

5.10.5.1 Test reports shall conform to [5.5.16.5](#) and include the implemented procedure for variations, justifications, and correlations to the conventional hydraulic operating acceptance criteria.

5.10.5.2 Alternative technologies may rely on a non-hydraulic signal for operation.

5.11 Design Assessment

5.11.1 The supplier/manufacture shall conduct a final design assessment to assure that the ASV, SSSV and/or secondary tools are suitable for the intended application and functional requirements. The assessment shall include as a minimum:

- a) review of functional requirements,
- b) review of technical specifications,
- c) review of design verification activities,
- d) review of design validation records (including any evaluation for scaling and special feature validation if applicable),
- e) review of design outputs and bill of materials.

5.11.2 The design assessment shall be conducted by individuals other than the individual who created the original design.

5.11.3 Copies of, or reference to, the actual design validation records shall be maintained in records of the design assessment. Records of the design assessment shall be maintained with the design documents.

6 Supplier/Manufacturer Requirements

6.1 General

This section contains the detailed requirements for the manufacture of SSSVs and secondary tools.

6.2 Documentation and Data Control

6.2.1 Retained Documentation

6.2.1.1 General

6.2.1.1.1 The supplier/manufacturer shall establish and maintain documented procedures to control all documents and data that relate to the requirements of this specification.

6.2.1.1.2 These documents and data shall be legible and maintained to demonstrate conformance to specified requirements.

6.2.1.1.3 All documents and data shall be retained in facilities that provide an environment that prevents damage, deterioration, or loss. Documents and data may be in the form of any type of media, such as hard copy or electronic media.

6.2.1.1.4 All documents and data shall be available and auditable by the user/purchaser; they shall be available within one week of request.

6.2.1.1.5 Documentation shall be retained for a minimum of 20 years from the date of manufacture—this requirement applies to products manufactured after the effective publication date of this standard.

NOTE Previous editions of this specification contained requirements to maintain documentation for five years.

6.2.1.2 Design Documentation

Design criteria, design verification, and design validation records for each size, type, and model, and the information listed below, shall be maintained for 20 years after the date of last manufacture of any scaled product and/or the base design:

- a) functional and technical specifications;
- b) one complete set of drawings, specifications, and standards;
- c) instructions providing methods for the assembly and disassembly of the equipment;
- d) operating manual for the SSSV and any required secondary tools;
- e) records of the functional test of the SSSV;
- f) records of design verification;
- g) records of design changes;
- h) design validation records shall contain sufficient documentation to identify and permit retrieval of:
 - all drawings and specifications applicable at the time of manufacture;
 - all applications for validation tests or retests;

- all design and/or material modifications, or other justification for retest, of SSSV equipment that did not pass any validation test;
- data that confirms successful completion of each required validation test.
- documentation of any scaling activities (see [5.8](#)).

6.2.2 Supplied Documentation

6.2.2.1 General

SSSVs shall be delivered with a supplier/manufacture's shipping report and an operating manual. Where a rated performance envelope is requested or required, the supplier/manufacture shall provide the rated performance envelope that conforms to [Annex M](#).

6.2.2.2 SSSV Shipping Report Contents

6.2.2.2.1 The SSSV shipping report shall contain the following information.

a) Manufacturer's data:

- manufacturer's name and manufacturing address;
- manufacturer's part number;
- equipment (name) type and model;
- serial number;
- nominal size;
- validation grade.

b) SSSV rated performance limits:

- RWP;
- maximum rated operating temperature;
- minimum rated operating temperature;
- secondary feature operation pressure; maximum; if applicable.

c) SSSV validation information:

- validation test agency;
- validation test number;
- date of report (month/day/year);
- validation by scaling or test.

d) SSSV functional test summary:

- opening pressure with zero pressure in test section: maximum and minimum; if applicable;

- closing pressure with zero pressure in test section: maximum and minimum; if applicable;
 - performed by—printed name and signature; date—month/day/year.
- e) Statement of compliance to user/purchaser specified requirements; if applicable.
- f) Inspected by—printed name and signature; month/day/year.

6.2.2.2.2 Additionally; the shipping report shall contain the following when applicable:

- a) SCSSV rated performance limits:
- control chamber pressure; maximum (at maximum operating temperature);
 - full open pressure at zero tubing pressure; maximum;
 - closing pressure at zero tubing pressure; minimum;
 - unequalized opening pressure differential; maximum.
- b) TRSV calculated performance limits (for V1-HR; V1-H; V1-R; V1; V2-R; V2 and V3-R; V3 TRSV):
- internal yield pressure (valve open; ends open; maximum rated operating temperature; exclusive of end connections; no applied loads);
 - collapse pressure; minimum (at ambient temperature);
 - collapse pressure; minimum (at maximum rated operating temperature);
 - tensile strength (at maximum internal pressure and ambient temperature);
 - tensile strength (at maximum internal pressure and maximum rated operating temperature);
 - tensile strength (without pressure at ambient temperature);
 - tensile strength (without pressure at maximum rated operating temperature).
- c) For SSCSV valves:
- orifice size;
 - setting spring;
 - number of spacers to be used;
 - pressure charge.
- d) For SSISV valves:
- minimum full open injection rate or velocity (velocity-type); or injection pressure (tubing-pressure-type);
 - maximum recommended injection rate or velocity;
 - full closed injection pressure (tubing-pressure-type).

6.2.2.3 SSSV Operating Manual Contents

The SSSV operating manual shall contain the following information:

- a) Size, type, and model.
- b) Validation grade.
- c) Operating data as follows:
 - RWP;
 - operating temperature range;
 - internal yield pressure;
 - collapse pressure (applies to tubing-retrievable SSSV equipment at maximum rated operating temperature);
 - tensile load strength (applies to tubing-retrievable SSSV equipment at maximum rated operating temperature);
 - rated performance envelope, if specified by the user/purchaser or required by the validation grade (see example in [Annex M](#)).
- d) Dimensional data necessary for installation and operation.
- e) Dimensions of drift bar and drift sleeve, if applicable.
- f) Calculations as follows:
 - SCSSVs—calculation procedures used to determine maximum fail-safe setting depths, where applicable;
 - SSCSVs—orifice coefficients, spring force, optimum operating range of pressure differential for velocity-type valves as applicable;
 - SSISVs—calculation procedures used to determine maximum fail-safe setting depths (tubing-pressure-type).
- g) Drawings and illustrations.
- h) Parts list with all necessary information for reordering, including supplier/manufacturer's contact information.
- i) Specific details of functional testing should be included if the test apparatus or procedures are significantly different than those included in this specification.
- j) Installation instructions.
- k) Retrieving instructions.
- l) Inspection and testing procedures.
- m) Troubleshooting and maintenance procedures.
- n) Repair limitations.

NOTE Repair limitations can include limits established on allowable wear of components, number of allowable repair cycles, type and extent of component replacements, or number of thread make/break cycles.



- o) Redress disassembling and reassembling requirements.
- p) Special feature operations and limitations.
- q) Secondary tool operations (see [6.2.2.4](#)).
- r) Gas bleed rate if applicable.
- s) Storage requirements to prevent damage caused by, for example, atmospheric conditions, handling, debris, radiation.
- t) Shelf life, if applicable.
- u) Operating requirements as follows:
 - SCSSVs—opening and closing procedures with opening and closing pressures;
 - SSCSVs—opening and closing procedures that shall include recommendations to avoid unintended closures and throttling;
 - SSISVs—opening and closing procedures with minimum opening and maximum recommended flow rate or velocity;
 - equalizing procedure, including maximum recommended unequalized opening pressure.
- v) For alternate technologies, see [5.10.3](#) for additional requirements.
- w) Landing nipple profile, if applicable (see [5.5.1.5](#)).

6.2.2.4 Secondary Tool Operating Manual Contents

The secondary tool operating manual shall be available and contain the following information:

- a) An abstract of the tool and its operation including identifying information.
- b) Drawings and illustrations.
- c) Operating instructions.
- d) Troubleshooting guide.
- e) Assembly and disassembly requirements including any hand or service tools, or equipment required.
- f) Repair and redress requirements that should contain the redress kit part number including a list of consumable parts.
- g) Storage requirements to prevent damage caused by, for example, atmospheric conditions, handling, debris, radiation.
- h) Shelf life, if applicable.

6.3 Product Identification

6.3.1 SSSV equipment furnished to this specification shall be permanently identified in accordance with the supplier/manufacture's written specifications. Identification shall include the following:

- a) manufacturer's name or trademark;