

Design, Installation, Operaton, Test, and Redress of Subsurface Safety Valve Systems

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Introduction

This document has been developed by users/purchasers and suppliers/manufacturers of subsurface safety valve (SSSV) equipment intended for use in the petroleum and natural gas industry worldwide. This document is intended to give requirements and information to both parties on the design, operation, installation, and testing of subsurface safety valve system equipment and also the storage/transport, maintenance, and redress of the SSSV equipment.

Users of this document should be aware that further or differing requirements might be needed for individual installations, storage/transport and maintenance. This document is not intended to inhibit the user/purchaser from accepting alternative engineering solutions. This may be particularly applicable where there is innovative or developing well-completion technology.

Significant revisions to the document include the following.

- Many former recommendations (shoulds) have become requirements (shalls).
- Alternate technologies for SSSV operation have been included.
- Secondary tools used in the servicing of tubing-retrievable type SSSVs have been included.
- Subsurface injection safety valves (SSISV) have been included.
- Information on insert-type valves for tubing-retrievable type SSSVs has been expanded.
- The annex describing testing of SSSVs has been changed from informative to normative. Examples have been added to illustrate various methods of calculating leakage rate for both liquid and gas leakage.
- The testing interval of surface controlled SSSVs (SCSSVs) has been limited to a maximum frequency of 12 months.

Design, Installation, Operation, Test, and Redress of Subsurface Safety Valve Systems

1 Scope

This document establishes requirements and provides guidelines for subsurface safety valve (SSSV) system equipment. This includes requirements for SSSV system design, installation, operation, testing, redress, support activities, documentation, and failure reporting. SSSV system equipment addressed by this document includes control systems, control lines, SSSVs, and secondary tools as defined herein. SSSV types including surface controlled (SCSSV), sub-surface controlled (SSCSV), and sub-surface injection safety valves (SSISV) are included. Requirements for testing of SSSVs including frequency and acceptance criteria are included. Alternate technology SSSV equipment and systems are included in these requirements.

This document is not applicable to design, qualification, or repair activities for SSSVs. This document does not specify when a SSSV is required.

NOTE API 14A provides requirements for SSSV equipment design, qualification, and repair.

2 Normative References

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

API Specification 14A, *Specification for Subsurface Safety Valve Equipment*

API Recommended Practice 14C, *Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms*

API Recommended Practice 14E, *Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems*

API Recommended Practice 14F, *Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations*

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

ISO 9000:2005 ¹, *Quality management systems—Fundamentals and vocabulary*

ISO 9712:2012, *Non-destructive testing—Qualification and certification of NDT personnel*

ASNT SNT-TC-1A ², *Personnel Qualification and Certification in Nondestructive Testing*

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

² American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228, www.asnt.org.

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

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

3.1.1

alternate technology SSSVs

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.

3.1.2

ambient-type valve

SSSV that is designed to close when tubing pressure drops below a pre-set level.

3.1.3

control line

Conduit utilized to transmit control signals to SCSSVs.

3.1.4

control system

Device or set of devices used to manage, command, direct, or regulate the behavior of the safety valve under normal operation and fail-safe conditions.

3.1.5

emergency shutdown system

System of stations which, when activated, initiate facility shutdown.

3.1.6

end sub

End component which provides connection between the tubing-retrievable safety valve (TRSV) and the tubing string and does not affect the functional operations of a TRSV.

3.1.7

equalizing feature

Mechanism which, when activated, permits the well pressure to bypass the SCSSV closure mechanism for the purposes of re-opening the SSSV.

3.1.8

fail-safe device

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

3.1.9

fail-safe setting depth

Maximum true vertical depth at which an SCSSV can be installed and will close under worst-case hydrostatic conditions.

3.1.10

maintenance

Service operations performed on SSSV system equipment as part of routine operations.

3.1.11

manufacturer

Principal agent in the design, fabrication, and furnishing of original SSSV system equipment.

3.1.12**operating manual**

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

3.1.13**operator**

User of SSSV system equipment.

3.1.14**orifice (bean)**

Designed restriction which causes the pressure drop in velocity-type SSCSVs.

3.1.15**packaging**

Enclosure(s) of sufficient structural integrity to protect contents from damage or contamination, including impacts and environmental conditions encountered during the various phases of transport.

3.1.16**qualified part**

Part manufactured under a recognized quality assurance program to meet the design and performance of the original part.

NOTE ISO 9001, API Spec Q1, and ISO TS29001 are examples of a recognized quality assurance program.

3.1.17**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.

3.1.18**rated working pressure**

The lesser of:

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

3.1.19**redress**

Any activity involving the replacement of **qualified parts** (3.1.16) within the limits described in Section 7.

3.1.20**repair**

Any activity beyond the scope of **redress** (3.1.19) that includes disassembly, re-assembly, and testing with or without the replacement of qualified parts and may include machining, welding, heat-treating, or other manufacturing operations, that restores the equipment to its original performance.

3.1.21**safety valve landing nipple****SVLN**

Any receptacle containing a profile designed for the installation of an SSSV lock mandrel.

NOTE SVLN may be ported for communication to an outside source for SSSV operation.

3.1.22**safety valve lock mandrel**

Retention device used for SSSV equipment.

3.1.23**secondary tool**

Tools and other equipment used with subsurface safety valves to perform a secondary function(s) or provide another intended design function.

NOTE Secondary tools may include communication, exercise, permanent lock open, temporary lock open, or other tools.

3.1.24**self-equalizing feature**

SCSSV mechanism which, on initiation of opening sequence of the SSSV, permits the well pressure to automatically bypass the SCSSV closure mechanism.

3.1.25**storage**

Act of retaining SSSV system equipment without damage or contamination, after processing is completed and prior to or after field use, including the transport process.

3.1.26**SSSV system equipment**

Components which include the **control system** (3.1.4), **control line** (3.1.3), **SSSV** (3.1.30), **safety valve lock mandrel** (3.1.22), **safety valve landing nipple** (3.1.21), flow couplings, **secondary tools** (3.1.23) and other related downhole control components.

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

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

NOTE A normally closed SCSSV requires a signal to open. Upon loss of that signal, the valve closes.

3.1.28**subsurface-controlled subsurface safety valve****SSCSV**

SSSV actuated by the characteristics of the well itself, such as velocity-type and ambient-type valves.

3.1.29**subsurface injection safety valve****SSISV**

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

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

3.1.30**subsurface safety valve****SSSV**

Device whose design function is to prevent uncontrolled well flow 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).

3.1.31 **surface safety valve** **SSV**

Automatic tree valve assembly which closes upon loss of power supply.

NOTE Where used in this document, the term Surface Safety Valve is understood to include an SSV valve and the SSV actuator.

3.1.32 **system integration manual**

Document issued by the operator (user/purchaser) which contains detailed data and instructions related to the configuration, preparation, installation, and operation of the SSSV system equipment.

3.1.33 **transport**

Actions required to ship SSSV system equipment from one geographic location to another.

3.1.34 **underwater safety valve** **USV**

Automatic valve assembly (installed at an underwater wellhead location) which will close upon loss of power supply.

NOTE Where used in this document, the term is understood to include a USV valve and USV actuator.

3.1.35 **velocity-type valve**

SSSV that is designed to close when the flow velocity exceeds a pre-set value.

3.1.36 **well test rate**

Stabilized rate at which the well is produced on a routine basis.

3.2 Acronyms and Abbreviations

ESD	emergency shut-down
FSSD	fail-safe setting depth
NDE	non-destructive examination
OPD	oil per day
SCSSV	surface-controlled subsurface safety valve
SSCSV	subsurface-controlled subsurface safety valve
SSISV	subsurface injection safety valve
SSSV	subsurface safety valve
SSV	surface safety valve
SVLN	safety valve landing nipple
TFL	through flow line
TRSV	tubing-retrievable safety valve

TR-SCSSV	tubing-retrievable surface-controlled subsurface safety valve
USV	underwater safety valve
WRSV	wire-line retrievable safety valve

4 Design

4.1 SSSV System Equipment

4.1.1 General

Subsurface safety valve systems (see 3.1.26 and Figure 1) are designed and installed to prevent uncontrolled well flow when actuated.

The user/purchaser, when developing the system configuration, shall consider and document the pertinent elements, their basis for acceptance and their compatibility. These elements include, at a minimum, the following: control system, control line, wellhead/tubing hanger passages and connectors, control line protectors, control fluid (for SCSSV); SSSV; flow couplings; locking and sealing devices (for wireline safety valves); safety-valve landing nipples; secondary tools and exposed fluids.

Examples of basis for acceptance may include:

- a) proven exploration and production experience or technology;
- b) proven alternative industry experience or technology;
- c) advanced design development, verification, and validation requirements;
- d) required time for valve closure from signal conforming to user/purchaser or regulatory requirements; or
- e) a combination of the previous elements.

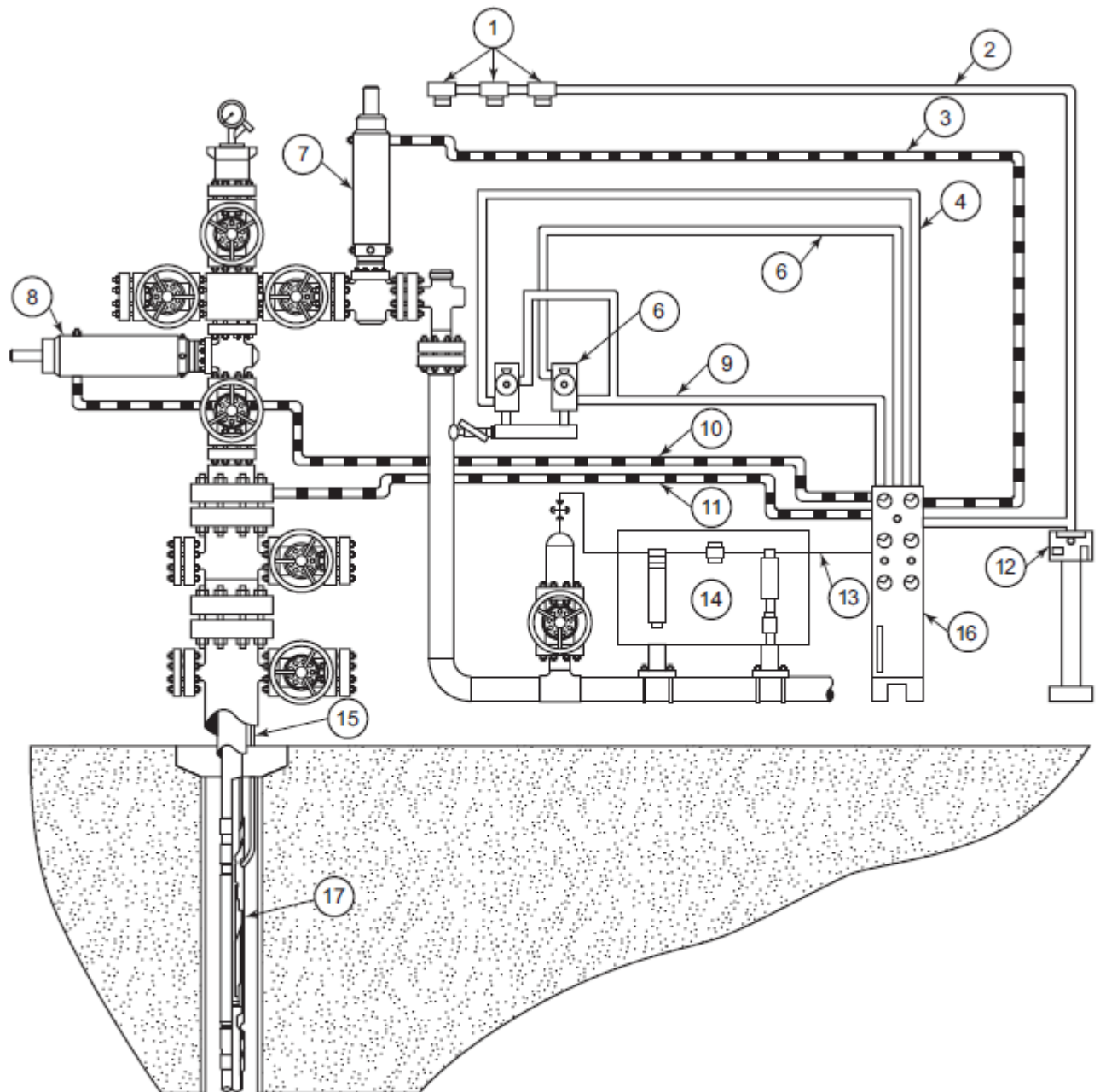
The user/purchaser shall assure that installation and installation testing of the SSSV system is performed and approved by a qualified person using documented procedures and acceptance criteria in accordance with the supplier/manufacture's operating manual and operator's system integration manual. System configuration and installation testing results shall become a part of the well records (see 8.4).

4.1.2 Materials

The user/purchaser shall verify that the materials used in SSSV system equipment are suitable for the functional and technical requirements of the system and the application.

NOTE The functional and technical requirements include the intended environment

SSSVs that include alternate technologies (3.1.1) for the operation of SSSVs may require special efforts to align them with the requirements of this document. The performance requirements for SSSV systems utilizing alternate technologies shall conform to the requirements of this RP to the extent the technology is practical. Variances to the requirements of this RP shall be identified, justified, and documented by a qualified person and approved by a second qualified person. Such documentation shall become a portion of the system's permanent records (8.4).

**Key**

- | | |
|---|---|
| 1 fusible plugs | 10 hydraulic/pneumatic pressure to master SSV |
| 2 ESD pressure line | 11 hydraulic pressure line to SCSSV |
| 3 hydraulic/pneumatic pressure line to wing valve | 12 manual remote emergency shutdown station |
| 4 high pilot signal | 13 supply line |
| 5 low pilot signal | 14 flowline scrubber assembly |
| 6 pilot box | 15 hydraulic pressure line to the SCSSV |
| 7 wing SSV hydraulic or pneumatic actuator | 16 hydraulic/pneumatic control panel |

Figure 1—Example: Surface-controlled Subsurface Safety Valve System in a Dry Tree Well

4.1.3 Interfaces

Equipment shall be selected and verified as being compatible with the dimensions and configurations of: tubing and auxiliary conduit connections; tubing and casing drift diameters; related permanent well equipment and well-servicing tools; and control or other fluids in contact with the equipment.

4.1.4 Pressures/Temperatures/Flow Rates/Loads

Equipment shall be selected and verified to meet or exceed the anticipated pressure range, temperature range, maximum/minimum flow rates, and anticipated loading conditions.

4.2 Control System

4.2.1 General

All elements of the control system shall be analyzed for potential hazards that may render the system vulnerable to failure or may preclude safe use. For example, automatic resets shall not be incorporated in the control system since this feature may cause the SCSSV to reopen when it should remain closed. Systems shall be designed and operated to address potential hazards.

It is desirable to integrate the SCSSV control system with the surface safety system to ensure the operational sequence as recommended in Annex D. The integrated system shall be designed to allow independent signal supply and control of the SCSSV. This feature will allow for routine maintenance and troubleshooting.

For multiple-well installations, the control-system manifolding should include provisions for individual well and SCSSV isolation.

Emergency shut-down (ESD) controls shall be installed in strategic locations in accordance with API 14C, applicable regulations and sound engineering judgment. To avoid closure of the SCSSV under full well-flow conditions, a delay shall be incorporated between closure of the tree valves controlled by the ESD and the downhole SCSSV. The opening sequence should be reversed on returning production facilities to normal operations. This delay mechanism shall be analyzed and documented to verify that it does not create hazards that render the system vulnerable to failure.

NOTE API 17F contains information relating to subsea production control systems.

4.2.2 Sensors

Each installation shall be analyzed to determine applicable sensors. The sensor types used to signal the SCSSV may include heat sensors, pressure sensors, fluid level sensors, and other sensors, as applicable.

A high/low level sensor may be placed on the supply tank of hydraulic systems to warn of abnormal operating conditions, e.g. well flowing through control line or a leaking control line. A low-pressure pilot may also be installed on the control system pump discharge.

4.2.3 Power

The system shall be designed with sufficient capacity to operate all equipment to the defined conditions of the application.

The following requirements apply to various types of control systems:

- a) Monitoring and controls shall be incorporated to prevent exceeding the limitations of the system.
- b) The control conduit shall have adequate considerations for returned control signals upon closure of the SCSSV.