

Recommended Practice for Subsea Pumping Well Intervention Systems

API RECOMMENDED PRACTICE 17G2
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Introduction

The purpose of a subsea pumping well intervention system (SPWIS) is to pump fluid into a subsea well. Due to barrier philosophy differences, pumping operations into or out of a flow line/pipeline or a subsea storage unit will not be addressed. This document also does not cover flow backs even though it is understood that the system is to be designed and operated in the presence of residual hydrocarbons in small quantity but not a full flow back scenario.

Subsea pumping systems typically involve a spooled fluid conduit with the fluid conduit not being rigidly attached to the subsea well, similar to a top tensioned intervention riser system. No tooling is conveyed through the fluid conduit; therefore, the mode of operation for these SPWISs is considered to be riserless. Commonly used fluid conduits typically consist of internally welded coil tubing, composite lines, umbilical lines, and other spooled products but can include jointed pipe. An SPWIS is a group of components or equipment packages that make up a standalone system or that may be a supplement to permanently installed subsea infrastructure operated together as an intervention system. The whole of the system needs to meet all the requirements of API Standard 17G and API Recommended Practice 17G5 as modified or amended by this document.

This document is not intended to inhibit a manufacturer from offering or the purchaser from accepting alternative equipment or engineering solutions for a specific application. This may be particularly applicable where there is innovative or developing technology.

Recommended Practice for Subsea Pumping Well Intervention Systems

1 Scope

This recommended practice provides recommendations for the design, manufacture, testing, and performance of SPWISs deployed from a mobile offshore work unit such as a multipurpose vessel. This document contains the system-level requirements and recommendations and where not found elsewhere, the information that applies to individual components. To the greatest extent possible, this document points the reader to the API document that is applicable to each system component or subsystem.

This information is applicable to all new and existing SPWISs.

SPWISs are intended to satisfy the requirements of API Standard 17G and API Recommended Practice 17G5, with modifications thereof as given in this document. Therefore, this document is not intended to be a standalone document. It is to be used in conjunction with API Standard 17G (parent document), API Recommended Practice 17G1, API Recommended Practice 17G5, and end user requirements.

This recommended practice is intended to serve as a common reference for designers, manufacturers, and operators/users, thereby reducing the need for end user specifications. This RP also eliminates the need for interpretation of the applicability of requirements given by other codes and standards for permanent installed equipment.

Specific equipment covered by this recommended practice is as follows:

- flying leads;
- vertical fluid conduits;
- jumpers;
- fluid conduit connectors;
- subsea safety module (SSM);
- control systems;
- disconnect systems.

Associated equipment not covered by this recommended practice is listed below:

- subsea pumps;
- subsea process packages;
- intervention vessels used to execute work in the field;
- winching, spooling, tensioners, injector heads, or other equipment to deploy fluid conduits.

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.

API Specification 5ST, *Specification for Coiled Tubing*

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

API Recommended Practice 17B, *Recommended Practice for Flexible Pipe*

API Specification 17D, *Design and Operation of Subsea Production Systems—Subsea Wellhead and Tree Equipment*

API Standard 17G, 3rd Edition, 2019. *Standard for Design and Manufacture of Subsea Well Intervention Equipment*

API Recommended Practice 17G1, *Configuration and Operation for Subsea Well Intervention Systems*

API Recommended Practice 17G5, *Recommended Practice for Subsea Intervention Workover Control Systems*

API Recommended Practice 17H, *Remotely Operated Tools and Interfaces on Subsea Production Systems*

API Specification 17J, *Specification for Unbonded Flexible Pipe*

API Specification 17K, *Specification for Bonded Flexible Pipe*

API Specification 17L1, *Specification for Flexible Pipe Ancillary Equipment*

API Recommended Practice 17L2, *Recommended Practice for Flexible Pipe Ancillary Equipment*

ASME B31.3, *Process Piping*

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

BS EN 14359, *Gas-loaded Accumulators for Fluid Power Applications*

DNV-OS-C501, *Composite Components*

DNV Standard for Certification 2.7-3, *Portable Offshore Units*

DNV-ST-F119, *Thermoplastic Composite Pipes*

ISO 10945, *Hydraulic Fluid Power-Gas-loaded Accumulators-Dimensions of Gas Ports*

NORSOK D002, *Well Intervention Equipment*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply, in addition to the terms defined in API Standard 17G, as applicable.

3.1.1

auto shut-in

A controlled sequence that is designed to automatically isolate the well subsea following an unintentional disconnect. The system requires capability of performing the expected sealing action under maximum allowable shut-in pressure (MASP) conditions as defined for the operation. Auto shut-in is analogous to the autoshear function as defined in API Recommended Practice 17G1, except there are no physical components conveyed downhole to shear.

Specifics of the design are based upon system architecture and safety strategy requirements.

3.1.2

disconnect system

A group of subsea components, equipment packages, and/or part of the temporarily installed subsea system infrastructure that provides the ability to disconnect the intervention vessel from the subsea equipment packages. This functionality facilitates disconnection of the fluid conduits at suitable angles.

3.1.3

downline

Lines in the water column that perform various purposes other than conveying fluid.

NOTE Downlines may be used to convey or suspend loads (crane or winch wires, synthetic rope), operate ROVs or support divers (ROV or diving bell umbilicals), send utilities, or control subsea equipment.

3.1.4

fluid conduit

Enclosed conduit that connects various system packages to allow for the flow of fluid between the various equipment packages and the tree system; typically consists of hose, steel coil tubing, or jointed pipe.

NOTE There are four groups of fluid conduits:

- deck fluid conduits (used to connect the various equipment on the deck of the intervention vessel);
- vertical fluid conduits (these are the conduits in the vertical water column);
- flying leads (these connect the vertical conduits to the equipment located on the seafloor and may provide the heave compensation capability to the system);
- jumpers (these provide the connection between equipment packages located on the seafloor).

3.1.5

fluid conduit connectors

Assemblies that connect the various fluid conduits to the various equipment packages and the well.

NOTE A fluid conduit connector may also provide a structural connection that supports loads from one or more equipment packages.

3.1.6

fluid storage package

Group of components intended to temporarily store intervention fluids prior to pumping to the well.

3.1.7

high-cycle fatigue

Accumulated material and structural damage induced by successive, alternating, low amplitude, elastic strains.

NOTE High-cycle fatigue is typically classified as requiring greater than 10,000 cycles to reach failure.

3.1.8

intervention fluid storage

Equipment that holds the intervention fluid upstream of the pump package.

NOTE The storage may be located on a surface intervention vessel or subsea.

3.1.9

low-cycle fatigue

Accumulated material structural damage induced by successive alternating, high amplitude, plastic strains.

NOTE Low-cycle fatigue is typically classified as requiring fewer than 1000 cycles to reach failure.

3.1.10**non-return valve**

Group of components intended to allow fluid flow toward the well but prevent fluid returns from the well toward the fluid conduits and topside infrastructure.

3.1.11**pumping manifold**

Assembly that contains the necessary piping and valves needed to direct the flow.

3.1.12**pumping package**

Equipment that provides the motive force to the fluid.

NOTE This package may be either located on the intervention vessel, subsea, or both.

3.1.13**safety functions**

Functions undertaken either autonomously or via operator action/intervention, in order to control fluid flow and prevent risk environment, personnel, or pumping well intervention system integrity.

3.1.14**subsea equipment package**

A system of integrated equipment and equipment packages, deployed subsea, that contains one or more of the following components:

- pumping package;
- fluid storage;
- fluid conduits;
- process package;
- fluid conduit connectors;
- pumping manifold;
- SSM;
- control system components;
- disconnect system;
- flexible fluid conduit;
- interfaces to the permanent installed subsea system infrastructure.

3.1.15**subsea IWOCS**

Group of components, equipment packages, and/or part of the permanent infrastructure that provide all the control functions required to operate the SPWIS in its entirety.

NOTE The control system is inclusive of backup control system, shut down system, and disconnect control system (if applicable).

3.1.16**subsea pumping equipment**

Subsea pumping equipment is a pump system that is located subsea and is typically used to pump from the sea floor to the surface or into subsea temporary infrastructure.

3.1.17**subsea safety module****SSM**

Group of components installed between the fluid conduit connector and tree and/or permanent infrastructure access point that provides some or all the barrier device(s) necessary to protect against uncontrolled flow to the subsea environment.

NOTE When mounted on top of a subsea tree, the requirements of the SSM may be subject to the overall requirements of a well control package (WCP), as defined in API Standard 17G.

3.1.18**weak link**

Group of components or design feature intended to limit tension during unplanned events including, but not limited to, vessel drift- or drive-off.

3.2 Acronyms and Abbreviations

For the purposes of this document, the following abbreviations and symbols apply.

AMV	annulus master valve
ASV	annulus swab valve
EQD	emergency quick disconnect
ESD	emergency shutdown
FMECA	failure mode, effects and criticality analysis
HAZID	hazard identification
HAZOP	hazard and operability study
IWOCS	intervention and workover control system
MAOP	maximum allowable operating pressure
OCTG	oil country tubular goods
PCV	production choke valve
PMV	production master valve
PSD	process shutdown
PSV	production swab valve
PWV	production wing valve
ROV	remotely operated vehicle
RP	recommended practice
RWP	rated working pressure
SCSSV	surface-controlled subsurface safety valve
SPWIS	subsea pumping well intervention system
SSM	subsea safety module
XOV	crossover valve

4 System Requirements

4.1 Purpose

4.1.1 General

For subsea pumping well intervention operations, the main modes of operation covered within the scope of this recommended practice are:

- surface-to-seafloor fluid conveyance mode;
- seafloor fluid conveyance mode.

Both modes are used principally to introduce fluid to the wellbore.

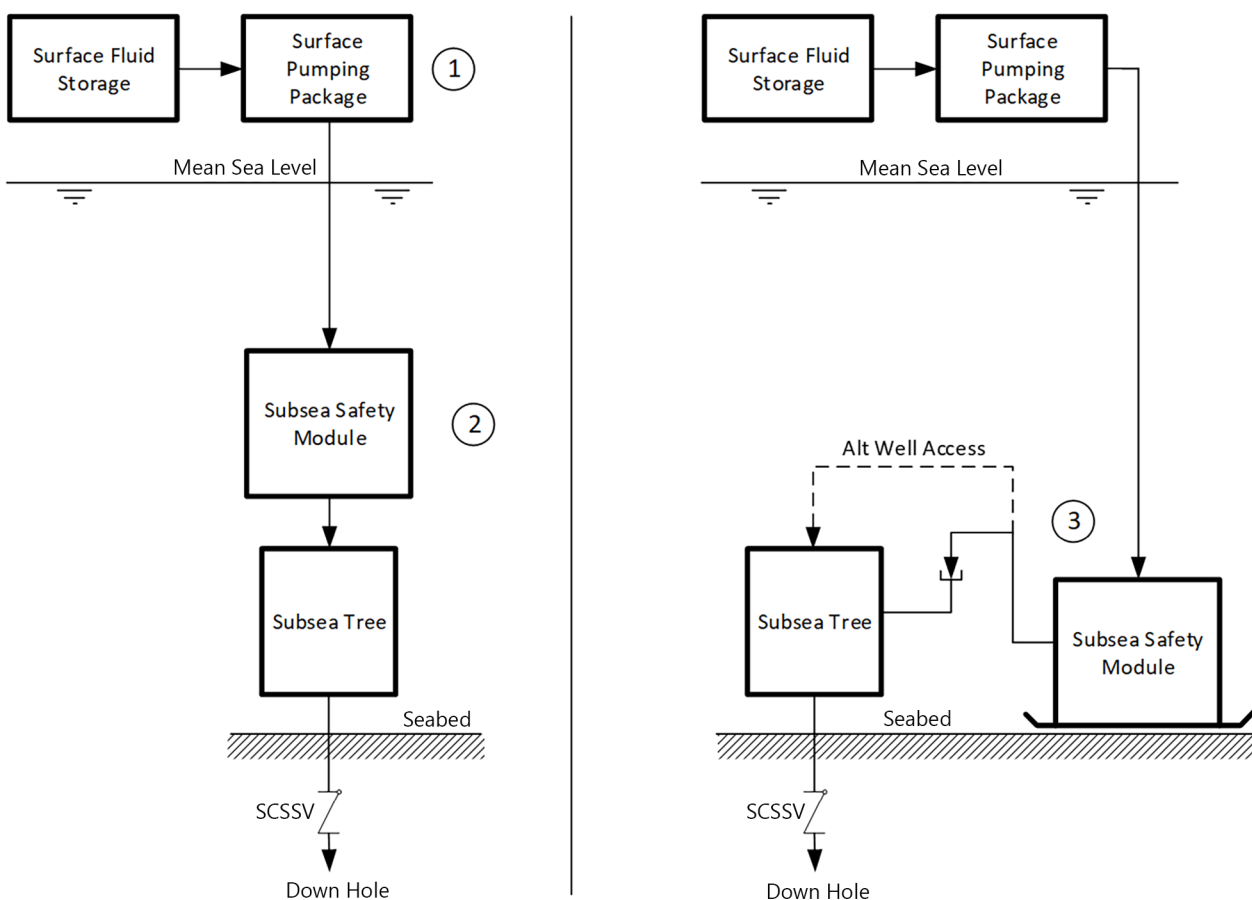
The mode of operation and the type of operation to be performed are dependent on the type of subsea tree and barrier elements included in the SPWIS.

Two simplified flow schematics for surface-to-seafloor fluid conveyance mode of operation is illustrated in [Figure 1](#). A simplified flow schematic for seafloor fluid conveyance mode is illustrated in [Figure 2](#).

4.1.2 Surface-to-seafloor Fluid Conveyance Mode

In this mode, one or more pumping packages are located on the intervention vessel. One or more vertical fluid conduits are deployed from the intervention vessel through the water column to convey the fluid to the subsea well on the seafloor. Flying leads connect the vertical fluid conduit to the SSM, which is located on a seafloor structure or landed on the subsea tree. A subsea pump package may be incorporated into this system to boost the pumping pressure.

Equipment shall resist external loads and pressure loads and accommodate tools for necessary operations. In surface-to-seafloor fluid conveyance mode, equipment may be exposed to ocean environmental loads such as hydrodynamic loads from waves and current in addition to intervention vessel motions.

**Key**

- 1 intervention fluids and/or pumping package may be aboard the SSM deployment vessel or a separate stim/frac vessel
- 2 SSM secured directly to subsea tree
- 3 SSM on seafloor (or alternate means to secure to seabed) with jumper(s) from the SSM to a subsea production/distribution manifold or directly into the subsea tree

Figure 1—SPWIS for Surface-to-seafloor Fluid Conveyance Mode

4.1.3 Seafloor Fluid Conveyance Mode

In this mode, no fluid is conveyed between the intervention vessel and the subsea infrastructure. The fluid storage and pumping packages are located on the sea floor and connected to the tree. Control of these packages is via umbilical back to the intervention vessel.

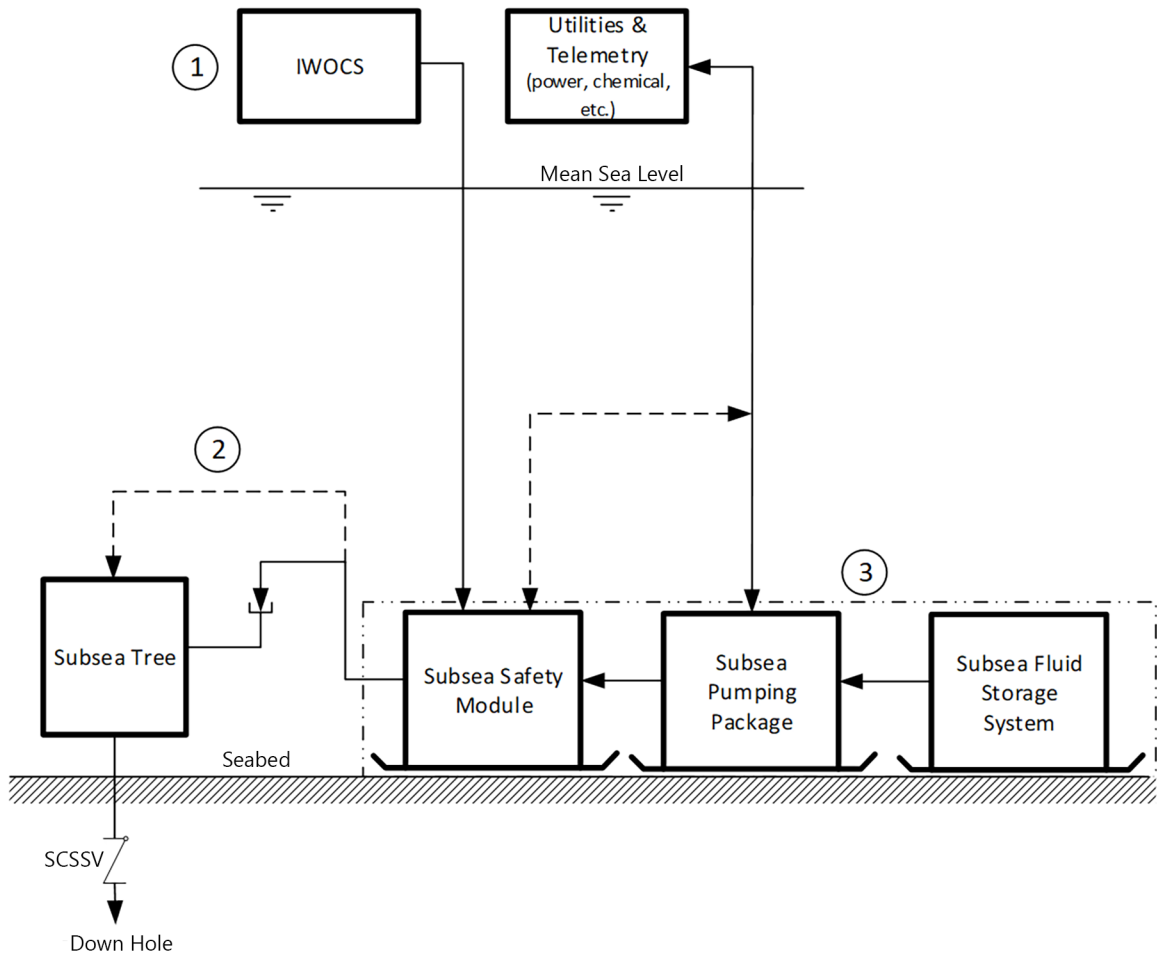


Figure 2—SPWIS for Seafloor Fluid Conveyance Mode

4.2 System Design

The purpose of system design is to ensure that SPWISs and their components are fit for purpose for their intended use as specified by end user.

System design shall be based on the requirements given in the design basis and in the system definition. The system design shall, as a minimum, be documented in terms of the following:

- a) system engineering, as prescribed within API Recommended Practice 17G1;
- b) system design specification comprising the system's operational, functional, and capacity requirements;
- c) system drawings;
- d) component design specifications;
- e) material selection;

- f) global analysis of fluid conduit system and equipment suspended in the water column, as per API Recommended Practice 17G1;
- g) FMEA or FMECA;
- h) SSM system hydraulic analysis, including emergency shutdown and disconnect response times;
- i) verification and validation plan.

4.3 Risk Assessment

Quantitative and qualitative risk analysis may be conducted to provide an estimation of the overall risk to health and safety, environment, and assets and typically includes consideration of the following:

- a) API Recommended Practice 17G1;
- b) HAZID;
- c) HAZOP;
- d) assessment of probabilities of failure events;
- e) accident developments;
- f) consequences assessment;

NOTE Local regulations may require risk analysis to be performed to identify critical scenarios that may affect the safety and reliability of the SPWIS.

4.4 Design Principles

SPWIS system design shall be in accordance with API Recommended Practice 17G1 and seek to eliminate or reduce hazards in lieu of hazard management or controls.

Common cause failures shall be identified, and measures shall be implemented to reduce their probability of occurrence or consequences.

On loss of control:

- a) all safety functions shall achieve a safe state;
- b) all well control devices designated as safety function class shall achieve a safe state.

For all operations, the system design shall account for the combinations of functional, environmental, and accidental loads, which can be predicted to occur simultaneously. It shall be documented that during the development of any identified accidental events, the SPWIS is unable to transmit forces of such magnitude as to compromise the well barriers.

4.5 Safety Strategy

A safety strategy shall be used in the design and operation of SPWISs, in accordance with API Recommended Practice 17G1 and the guidance given in API Recommended Practice 17G5.

The safety strategy: