



GUIDE FOR CLASSIFICATION AND CERTIFICATION OF

SUBSEA PRODUCTION SYSTEMS, EQUIPMENT AND COMPONENTS

AUGUST 2017

**American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862**

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ABS Plaza
16855 Northchase Drive
Houston, TX 77060 USA**

Foreword

The advantages of subsea systems have made subsea production a top choice for developments in many environments around the world. Innovations and improvements are being introduced that will increase the reliability and robustness of these systems, which will be used in even more developments over time.

Verification and validation plays an important role in safe and reliable operations of these subsea production systems. This Guide specifies the ABS requirements and process for Certification and Classification of subsea production systems and their associated subsystems, equipment and/or components. An optional class notation **✕ CSS – Production** is offered for a subsea production system that has been reviewed, surveyed, installed and commissioned in full compliance with the applicable sections of this Guide.

In addition, Independent third party (I3P) services that can be provided by ABS at different project phases are also described in this Guide. These are customized services based on the request of clients and could include the following:

- Design verification (design review) and design validation (survey during manufacturing)
- Installation/commissioning verification
- In-service examination
- Life extension assessment
- Decommissioning verification

Certified Verification Agent (CVA) review to meet the government requirements can be provided during design, manufacturing and installation phases for subsea risers. For safety and pollution prevention equipment (SPPE) and subsea equipment in high-pressure high-temperature (HPHT) applications, I3P services for conformance with 30 CFR 250 Subpart H and applicable BSEE requirements can also be provided.

This Guide is to be used in conjunction with other applicable ABS Rules and Guides, codes and standards as referenced therein, and applicable national regulations.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



GUIDE FOR CLASSIFICATION AND CERTIFICATION OF SUBSEA PRODUCTION SYSTEMS, EQUIPMENT AND COMPONENTS

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SECTION 1 Scope and Conditions of Classification and Certification

The general requirements for conditions of Classification and Certification are contained in the *ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1)*. Additional requirements specific to subsea production systems are contained in this Guide.

This Guide describes the requirements and process for ABS Certification, Classification and independent third party (I3P) services for subsea production systems and their associated subsystems, equipment and/or components.

Certification typically includes design review and survey during manufacturing and may include survey during installation/commissioning for certain subsystem/equipment. Classification can be offered to subsea production systems after successful Certification and installation/commissioning verification. The continuance of the Classification of subsea production systems during their service lives is dependent on meeting the requirements contained in this Guide for periodical surveys.

In addition to Certification and Classification services, I3P services for subsea production systems, subsystems, equipment and/or components include design verification, design validation, installation/commissioning verification, in-service examination, life extension assessment and decommissioning verification. Certified Verification Agent (CVA) service to meet the government requirements can also be provided during design, manufacturing and installation phases for subsea equipment. I3P services for subsea equipment in US Outer Continental Shelf (OCS) for conformance with 30 CFR 250 Subpart H can be provided as described in Appendix 1.

The definitions of *Subsea Production System*, *Subsea Production Subsystem*, *Equipment* and *Components* as applied within this Guide are as follows:

Subsea Production System. An assemblage of equipment used for producing oil and natural gas. At a minimum, the subsea production system consists of a wellhead, a tree, electrical and control systems, a flowline and/or a riser.

Subsea Production Subsystem. Electrical systems, control systems, injection systems and service systems with/without connected equipment.

Equipment. The highest level of an assembly with a bounded function (e.g., wellhead, tree, flowline, jumper, riser, manifold, etc.).

Component. A unit in the equipment designed to serve a specific function (e.g., valve, connector, choke, etc.).

1 Certification

Upon request of the Owner/Operator or Designer/Manufacturer, and where permitted by the recognized Authority, ABS will issue Certificates for subsea production systems, subsystems, equipment and/or components provided that the requirements in this Guide are met and pertinent governmental requirements are fulfilled.

The Certification service includes design review and survey during manufacturing, and ABS issuances for Certification service are:

- For design review
 - Design review letter (DRL) or
 - Independent review certificate (IRC) for primary pressure barrier components

- For survey during manufacturing
 - Survey report (SR) and/or
 - Certificate of conformity (CoC) for primary pressure barrier components

SR and/or CoC will be issued after the installation/commissioning phase for:

- Systems/Subsystems
- Equipment: wellheads, risers, pipelines, umbilicals and high integrity pressure protection system (HIPPS)

SR and/or CoC will be issued after the manufacturing phase for:

- Equipment other than those listed above
- Components

Section 4 provides details on the Certification process and codes for certification of subsea production systems, subsystem, equipment and components. Appendices 3, 4, 6 and 7 show examples of DRL, IRC, SR, and CoC, respectively.

3 Classification (Optional)

Upon request of the Owner/Operator, optional Classification services can be offered for subsea systems provided the classification requirements in this Guide are met including

- i) Certification/Verification requirements in Section 2 through Subsection 6/3 for design, manufacturing, and installation phases
- ii) Periodical survey requirements in Subsection 6/5 for operation phase

Classification is a life cycle process extending from design, manufacturing, installation, commissioning, and continued through service life. Product Certification can be the first step of Classification. Following installation/commissioning verification, the continuance of the Classification of subsea production systems/subsystems during their service lives is dependent on meeting the requirements contained in this Guide for periodical surveys.

3.1 ABS Class Notation

Subsea production systems that have been reviewed to the satisfaction of ABS as well as built, installed and commissioned to the satisfaction of the ABS Surveyors to the full requirements of this Guide, where approved by the Committee for service under the specified design environmental conditions, may be classed and distinguished in the *ABS Record* by the notation **✕ CSS – Production**.

3.3 Systems Not Built Under Survey

The symbol “✕” (Maltese Cross) signifies that the subsea production systems were reviewed to the satisfaction of ABS as well as built, installed and commissioned to the satisfaction of the ABS Surveyors. Subsea production systems that have not been reviewed by ABS or built under ABS survey, but which are submitted for Classification, will be subjected to special consideration under the following conditions.

- The systems meet all the requirements in this Guide
- The original design documents are available for ABS review
- Manufacturer databook and material traceability are available for ABS review
- Previous Classification/Certification certificates are available

Where found satisfactory and thereafter approved by the Committee, subsea production systems may be classed and distinguished in the *Record* by the notation described above, but the symbol “✕” signifying survey during construction will be omitted.

5 I3P Services

I3P services are customized services based on the request of clients. Upon request, provided the requirements of this Guide and related ABS documents are met, ABS will provide independent services as follows.

- Design verification (design review) and design validation (survey during manufacturing)
- Installation/commissioning verification
- In-service examination
- Life extension assessment
- Decommissioning verification

Upon request of the client, Certified Verification Agent (CVA) service to meet government requirements can also be provided during design, manufacturing and installation phases for subsea risers. For safety and pollution prevention equipment (SPPE) and subsea equipment in high-pressure high-temperature (HPHT) applications, I3P services for conformance with 30 CFR 250 Subpart H and applicable BSEE requirements are available as detailed in Appendix 1.

ABS deliverables for these I3P services vary based on client request and scope of related services. Examples of ABS deliverables may be engineering review report/letter, survey report, CVA report, or I3P report.

The client should contact ABS for assistance in planning I3P services for their subsea production systems, subsystems, equipment and/or components.

Section 1, Table 1 lists I3P services for the different phases of design, manufacturing, installation/commissioning, operation and decommissioning.

TABLE 1
I3P Services for the Different Phases of Design, Manufacturing, Installation/Commissioning, Operation and Decommissioning

Phase Level	Design	Manufacturing	Installation/ Commissioning	Operation		Decommissioning
	Design Verification	Design Validation	Installation/ Commissioning Verification	In-service Examination	Life Extension Assessment	Decommissioning Verification
System	R	S	R*, S	S	R, S	R, S
Subsystem	R	S	R*, S	S	R, S	R, S
Equipment	R	S	R*, S	S	R, S	R, S
Component	R	S		S		

Notes:

R – Engineering Review

S – Survey

* – If not reviewed during design phase

Upon request of the client, ABS may grant an “Approval in Principle” (AIP) at an early conceptual design phase to assist the client in demonstrating project feasibility to its project partners and regulatory bodies. For the detailed process of AIP, reference can be made to the *ABS Guidance Notes on Review and Approval of Novel Concepts*.

For new designs (materials, components, equipment or systems), new processes or procedures with no prior in-service experience and/or any classification rules, statutory regulations or industry standards directly applicable to them, the ABS “New Technology Qualification” program can help clients to qualify that the new technology is able to perform intended functions in accordance with defined performance requirements. The process of this qualification program is contained in the *ABS Guidance Notes on Qualifying New Technologies*.

7 Application and Scope

7.1 Application

This Guide is applicable to subsea production systems, subsystems, equipment, and/or components listed in 1/7.3. This Guide is intended for use in conjunction with codes and standards listed in Appendix 2 as referred to in Section 3, as well as the latest edition of the following or other applicable ABS Rules and Guides.

- *ABS Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)*
- *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*
- *ABS Rules for Building and Classing Offshore Support Vessels (OSV Rules)*
- *ABS Rules for Building and Classing Floating Production Installations (FPI Rules)*
- *ABS Rules for Building and Classing Facilities on Offshore Installations (Facilities Rules)*
- *ABS Guide for Building and Classing Subsea Riser Systems (Riser Guide)*
- *ABS Guide for Building and Classing Subsea Pipeline Systems (Pipeline Guide)*

7.3 Scope

This Guide covers subsea production systems, subsystems, equipment, and/or components used in connection with hydrocarbon well subsea production, completion, and workover operations.

The subsea production system includes, but is not limited to

- Wellhead, Tree and Tubing Hanger
- Flowline, Jumper and Riser
- HIPPS*
- Manifold/PLET/PLEM and Template
- Injection and Service Systems
- Umbilical/Flying Lead**
- Electrical System
- Control and Monitoring System
- Capping Stack
- Flow Meter
- Remotely Operated Vehicle (ROV)/Remotely Operated Tool (ROT) Interfaces
- Foundation
- Subsea Protection Structure

Notes:

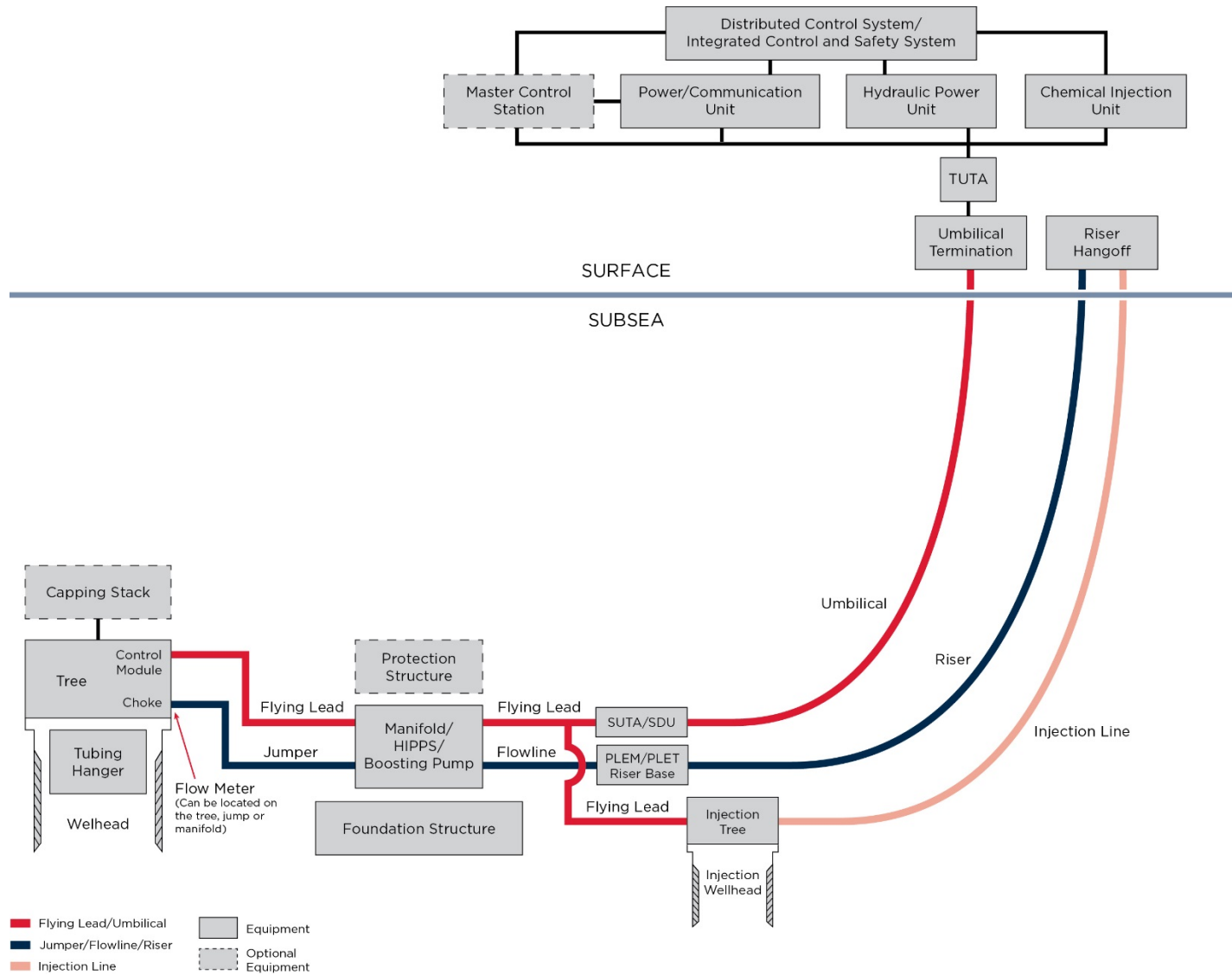
* *HIPPS is part of the control and monitoring system*

** *Umbilical/flying lead is part of the electrical, control and monitoring system*

Section 1, Figure 1 shows the typical elements in a subsea production system. Actual subsea fields may contain fewer or more elements than those shown in Section 1, Figure 1.

For a detailed list of components for each subsystem/equipment covered in this Guide, see Section 4, Table 1.

FIGURE 1
Typical Elements in a Subsea Production System



7.5 Alternatives

7.5.1 General

ABS is ready to consider alternative arrangements and designs which can be shown through either satisfactory service experience or a systematic analysis based on sound engineering principles, to meet the overall safety, serviceability, and design standards of the Rules and Guides.

7.5.2 National Standards

- i) ABS will consider special arrangements or design of subsea production systems, subsystems, equipment and/or components which can be shown to comply with standards recognized in the country, provided that the proposed standards are not less effective.
- ii) When alternate standards are proposed, comparative analyses are to be provided to demonstrate equivalent level of safety to the recognized standards as listed in this Guide and to be performed in accordance with 1/7.9.

7.7 New Technologies and Novel Concepts

Subsea production systems, subsystems, equipment and/or components which contain novel design features to which the provisions of this Guide are not directly applicable may be classed/certified when approved by ABS on the basis that this Guide, insofar as applicable, has been complied with and that special consideration has been given to these aspects based on the best information available at that time. Justifications for the new or novel features can be accomplished by applying 1/7.9.

7.9 Risk Evaluations for Alternative Arrangements and Novel Features

- i) Risk evaluations for the justification of alternative arrangements or novel features may be applicable either to the subsea production system as a whole, or to individual subsystems, equipment and/or components.
- ii) ABS will consider the application of risk evaluations for alternative arrangements and novel features in the design of the subsea production system, subsystems, equipment and/or components, verification surveys during construction, and surveys for maintenance of Class.
- iii) When applied, risk assessment techniques are to demonstrate that alternative arrangements and/or novel features provide acceptable levels of safety in line with current offshore and marine industry practice.
- iv) Portions of the subsea production system or any of its subsystems, equipment and/or components not explicitly included in the risk evaluation submitted to ABS are to comply with any applicable part of the ABS Rules and Guides.
- v) If any proposed alternative arrangement or novel feature affects any applicable requirements of flag and coastal State, it is the responsibility of the Owner/Operator to discuss with the applicable authorities the acceptance of alternatives based on risk evaluations.

The *ABS Guidance Notes on Review and Approval of Novel Concepts*, *ABS Guidance Notes on Qualifying New Technologies*, and *ABS Guide for Risk Evaluations for the Classification of Marine-Related Facilities* provide guidance to ABS clients on the preparation of a risk evaluation to demonstrate equivalency or acceptability for a proposed subsea production system design.

7.11 Certification and Classification Process

7.11.1 Certification Process

- i) Section 4 provides the ABS Classification/Certification process for subsea production systems, subsystem, equipment, and components. Subsequently, Section 4, Table 1 identifies the typical subsea production systems, subsystems, equipment, and/or components that are part of the ABS Classification/Certification process.
- ii) Related subsea production systems, subsystems, equipment and component drawings, calculations and documentation are required to be submitted to ABS by entities as listed in Section 2 to substantiate that the design of the systems, subsystems, equipment and/or components are in compliance with this Guide, and applicable codes or standards, as listed in this Guide.

- iii) Upon satisfactory completion of ABS review of design documents, ABS Engineers will issue an ABS review letter and/or an Independent Review Certificate (IRC), as specified in Section 4, Table 1. This letter or IRC, in conjunction with ABS-approved documentation, will be used and referenced during surveys.
- iv) Upon satisfactory completion of survey, ABS Surveyors will issue appropriate survey reports.

7.11.2 Classification Process

See Items i) through iv) above and the following.

- v) Upon satisfactory completion of all of the required engineering design review and survey processes (inspection, testing, installation and commissioning), ABS may issue a Classification Certificate to the subsea production systems.

9 Other Regulations

9.1 International and Other Regulations

- i) This Guide covers the requirements for the Classification/Certification of subsea production systems, subsystems, equipment, and/or components. In addition, Owner/Operators, designers and builders are directed to the regulations of international, governmental and other authorities addressing those requirements in addition to or over and above the Classification/Certification requirements.
- ii) Where authorized by the Administration of a country signatory thereto and upon request of the Owner/Operator of a classed subsea production system or one intended to be classed/certified, ABS will survey for compliance with the provisions of International and Governmental Conventions and Codes, as applicable.

9.3 Governmental Regulations

Where authorized by a government agency and upon request of the Owner/Operator of a new or existing subsea production system, ABS will survey and class/certify subsea production systems, their associated subsystems, equipment and/or components for compliance with particular regulations of that government on their behalf.

11 References

In addition to the ABS *Rules and Guides* denoted in 1/7.1, and codes and standards in Appendix 2, additional references can be made to the following:

- *ABS Rules for Building and Classing Offshore Installations (Offshore Installations Rules)*
- *ABS Guide for Buckling and Ultimate Strength Assessment for Offshore Structures*
- *ABS Guide for Certification of Lifting Appliances (Lifting Appliances Guide)*
- *ABS Guide for Nondestructive Inspection of Hull Welds (NDI Guide)*
- *ABS Guide for Remote Control and Monitoring for Auxiliary Machinery and Systems (other than Propulsion) on Offshore Installations*
- *ABS Guide for Risk Evaluations for the Classification of Marine-Related Facilities*
- *ABS Guide for Surveys Based on Machinery Reliability and Maintenance Techniques*
- *ABS Guide for Surveys Using Risk-Based Inspections for the Offshore Industry*
- *ABS Guidance Notes on Qualifying New Technologies*
- *ABS Guidance Notes on Review and Approval of Novel Concepts*
- *ABS Guidance Notes on Risk Assessment Applications for the Marine and Offshore Oil and Gas Industries*
- *ABS Guidance Notes on Subsea Hybrid Riser Systems*
- *ABS Guidance Notes on Subsea Pipeline Route Determination*

ABS is prepared to consider other recognized codes, standards, alternative design methodology and industry practice, on a case-by-case basis, with justification as indicated in 1/7.5.

13 Definitions

The following terms are used in this Guide:

Choke. A device that controls pressure and flow rate by a fixed or adjustable amount.

Barrier. An element forming part of a pressure-containing envelope that is designed to prevent unintentional flow of production/injected fluids, particularly to the external environment.

Charpy V-Notch Test: A test to reveal fracture toughness in terms of energy absorbed or lateral expansion or fracture appearance.

Client. Operator, Owner, Designer or Manufacturer.

Cluster Manifold. A structure used to support a manifold for produced or injected fluids.

Communication Distribution Unit (CDU). A unit that communicates with the host facility and distributes communication signals within the subsea network in an electrohydraulic or electric system.

Completion Riser. A temporary riser that is designed to run inside a BOP and drilling riser to allow for well completion. Completion operations are performed within the drilling riser. A completion riser can also be used for open-sea workover operations.

Completion/Workover (C/WO) Riser. A temporary riser used for completion or workover operations.

Control Path. The total distance that a control signal (e.g., electrical, optical, hydraulic) travels from the topside control system to the subsea control module (SCM) or valve actuator.

Corrosion Allowance. The amount of wall thickness added to the pipe or component to allow for corrosion, scaling, abrasion, erosion, wear and all forms of material loss.

Corrosion-Resistant Alloy (CRA). A non-ferrous alloy for which any one or the sum of the specified amount of the following alloy elements exceeds 50 %: titanium, nickel, cobalt, chromium and molybdenum.

Corrosion-Resistant Material (CRM). A ferrous or non-ferrous alloy that is more corrosion resistant than low-alloy steels.

Crack Tip Opening Displacement (CTOD). The measure of crack severity that can be compared against a critical value at the onset of crack propagation.

Depth Rating. The maximum rated working depth for a piece of equipment at a given set of operating conditions.

Design Basis. A set of project-specific design data and functional requirements that are not specified or are left open in the general standard.

Design Criteria. Quantitative formulations which describe each failure mode the conditions shall fulfil.

Design Factor. A factor (usage factor) used in working stress design.

Design Load. A combination of load effects.

Direct Hydraulic Control. A control method wherein hydraulic pressure is applied through an umbilical line to act directly on a subsea valve actuator.

Down Time. The time interval during which an item is unable to perform a required function due to a fault, or other activities (e.g., during maintenance).

Drift-Off. Unintended lateral movement of a dynamically positioned vessel off its intended location relative to the wellhead, generally caused by loss of stationkeeping control or propulsion.

Drilling Template. A multi-well template used as a drilling guide to predrill wells prior to installing a surface facility.

Driven Pile. Typically a tall steel cylindrical structure, with or without internal stiffener system, used to support subsea structures.

Drive-Off. Unintended movement of a dynamically positioned vessel off location driven by the vessel's main propulsion or station-keeping thrusters.

Dual Redundant. Two segregated, independent components, systems, or elements, where one serves as a backup to the other; or two identical units (or systems) fulfilling the same function.

Electric Control. A control method wherein communication signals and power are conducted to the subsea system and use electric motors to open or close subsea valves.

Electrohydraulic Control. A control method wherein communication signals are conducted to the subsea system. The signals both control and operate electrically powered functions in the subsea system.

Emergency Shutdown. The controlled sequence of events ensuring that the well is secured against accidental release of hydrocarbons into the environment (i.e., closing of barrier elements).

Emergency Shutdown (ESD) System. A system of manual stations that, when activated, initiates facility shutdown.

End Fitting. The termination in a flexible pipe.

End Termination. A mechanical fitting that is attached to the end of an umbilical and that provides a means of transferring installation and operating loads, fluid and electrical services to a mating assembly mounted on the subsea facility or surface facility.

Environmental Loads. Loads due to the environment.

Export Line. A pipeline that transports processed oil and/or gas fluids between platforms or between a platform and a shore facility.

Extended Factory Acceptance Test (EFAT). A test conducted to verify that the specified requirements, for a set of interfacing products, have been fulfilled.

Factory Acceptance Test (FAT). A test conducted to verify that the specified requirements, for a product, have been fulfilled.

Fail-Safe. A term applied to equipment or a system so designed that, in the event of failure or malfunction of any part of the system, devices are automatically activated to stabilize or secure the safety of the operation.

Failure. An event causing an undesirable condition (e.g., loss of component or system function) or deterioration of functional capability to such an extent that the safety of the unit, personnel, or environment is significantly reduced

Failure Mode. The effect by which a failure is observed on the failed item [i.e., the loss of a required functionality (e.g., loss of containment)].

Fault. The state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

Final Element. Part of a safety instrumented system that implements the physical action necessary to achieve a safe state.

Flexible Joint. A laminated metal and elastomer assembly, having a central through-passage equal to or greater in diameter than the interfacing pipe or tubing bore, that is positioned in the riser string to reduce the local bending stresses.

Flowline. A pipeline that transports the well fluids from the wellhead to the first downstream process component.

Flowline Jumper. A length of pipe terminated by connector systems between two subsea structures.

Flying Lead. Single or multiple composite grouping of hydraulic, chemical, electrical power, electrical signal, and/or optical signal carrying conduits used to interconnect various items of subsea equipment. Flying leads may be designed for remotely operated vehicle (ROV) or remotely operated tool (ROT) assisted deployment.

Fortified Section. Piping and equipment with an intermediate pressure rating somewhere between the SIP (high) and MAWP (low) ratings.

Fracture Mechanics Assessment. Assessment and analysis where critical defect sizes under design loads are identified to determine the crack growth life (i.e., leak or fracture).

Fracture Toughness. The property of a material that measures the resistance-to-failure resulting from crack propagation.

Functional Loads. Loads that are a consequence of the system's existence and use without consideration of environmental or accidental effects.

Guideline. A taut line from the seafloor to the surface for the purpose of guiding equipment to the seafloor structure.

High Integrity Pressure Protection System (HIPPS). Mechanical and electrical-hydraulic SIS used to protect production assets from high-pressure upsets.

High-Pressure High-Temperature (HPHT). Refers to wells with a potential pressure greater than 103.43 MPa (15,000 psia), or with a potential temperature greater than 177°C (350°F), up to 288°C (550°F), measured at the mudline.

Horizontal Tree. A tree that does not have a production master valve in the vertical bore but in the horizontal outlets to the side.

Hydraulic Connector. A mechanical connector that is activated hydraulically.

Hydraulic Rated Working Pressure. The maximum internal pressure that the hydraulic equipment is designed to contain and/or control.

Hydrostatic Pressure. The maximum external pressure of ambient ocean environment (maximum water depth) that equipment is designed to contain and/or control.

Injection Line. A pipeline that directs liquids or gases into a formation, wellhead, or riser, to support hydrocarbon production activity (i.e., water or gas injection, gas lift, or chemical injection lines, etc.).

Inspection. The examination of an item in accordance with a specified standard.

Inspection and Test Plan. The minimum requirement of the activities for quality control and inspection agreed prior to commencement of work.

Intelligent Well Control System (IWCS). A control system used to operate an intelligent well.

Interchangeability Test (ICT). A test conducted to verify the interchangeability requirements of "identical" products, which may be interfaced with other mating products at the installation site, have been fulfilled.

Lifting Device. A tool dedicated for lifting.

Load Case: The combination of simultaneously acting loads.

Load Effect. The effect of a single load or combination of loads on the structure, such as stress, strain, deformation, displacement, or motion, etc.

Loading Conditions:

- i) *Normal Operation Loading Condition.* Conditions which include routine operation of the subsea system and equipment.
- ii) *Extreme Operation Loading Condition.* Conditions which include the unavoidable but predictable conditions due to the environmental and operating scenarios.
- iii) *Accidental/Survival Loading Condition.* Conditions which include the unplanned, unavoidable, and unpredictable conditions due to the environmental, system/equipment malfunctioning, emergency operation, collision impact, abnormal environmental conditions or any other scenarios defined by operators.
- iv) *Temporary Loading Condition.* Conditions include testing, transportation, drilling and/or completion, installation, well intervention, and decommissioning.
 - *Testing Condition Loading Conditions.* Conditions which include hydrotesting, FAT, SIT, etc.
 - *Transportation Loading Condition.* Conditions which include lifting/handling, load-out, etc.
 - *Drilling and/or Completion Loading Condition.* Conditions during drilling and completion operation are to following API RP 16Q and API RP 17G, respectively.

- *Installation Loading Condition.* Conditions which include deployment, abandonment and retrieval, etc.
- *Well Intervention Loading Condition.* Conditions during well intervention, including the loads from riser, wireline and coiled tubing etc., as defined in API RP 17G.
- *Decommissioning Loading Condition.* Conditions which include removal of seabed equipment.

Logic Solver. In relation to a HIPPS, a Logic Solver is the portion of an SIS that performs one or more logic function(s) related to the safety function(s).

Malfunction. Any condition of a device or an equipment item that causes it to operate improperly, but does not prevent the performance of its design function.

Manifold. The system of headers, branched piping and valves used to gather produced fluids or to distribute injected fluids in subsea oil and gas production systems.

Material Data Sheet. A document containing data regarding the physical and mechanical properties of a particular material used in the insulation process and guidelines and recommendations for its processing and use.

Maximum Allowable Working Pressure (MAWP). The highest operating pressure allowable at any point in any component other than a flowline during normal operation or static conditions.

Modular Template. A template installed as one unit or as modules assembled around a base structure (often the first well).

Mudmat. Typically a shallow structure used to support a subsea structure by distributing the load to the seabed via a structural plate or shallow skirt.

Operating Pressure. Pressure in the equipment when the plant operates at steady state condition, subject to normal variation in operating parameters.

Operating Temperature. The maximum and/or minimum temperature experienced during installation and operation of the equipment.

Pipeline. Piping that transports fluids between offshore production facilities or between a platform and a shore facility, often sub-classified into the three categories: flowlines, injection lines, and export lines.

Pipeline End Manifold (PLEM). A system of headers, piping and valves used to gather produced fluids or to distribute injected fluids in subsea production systems, generally integral to the pipeline and having more than one subsea connection.

Pipeline End Termination (PLET). A system of piping and valves, generally integral to the pipeline, used to make a subsea connection at the end of a pipeline.

Pre-Deployment Test (PDT). A test conducted to verify that the specified requirements, for a product that is ready for deployment, are still fulfilled.

Pressure-Containing. A part exposed to wellbore fluids, whose failure to function as intended results in a release of wellbore fluid to the environment.

Pressure-Controlling. A part that is intended to control or regulate the movement of pressurized fluids.

Protection Structure. The independent structure that protects subsea equipment against damage from dropped objects, fishing gear and other relevant accidental loads.

Rated Working Pressure (RWP). The maximum internal pressure that equipment is designed to contain and/or control.

Reliability. The likelihood of a given piece of safety-related equipment to remain in operation for the expected duration.

Remotely Operated Tool (ROT) System. A dedicated, unmanned, subsea tools used for installation and inspection, maintenance, and repair (IMR) tasks that require lift and/or handling capacity beyond that of free-swimming ROV systems.

Remotely Operated Vehicle (ROV). Free-swimming or tethered submersible craft used to perform tasks such as inspection, valve operations, hydraulic functions, and other general tasks.

Rigid Jumper. A flowline jumper fabricated using steel pipe, as opposed to flexible pipe.

Riser Base. A structure that supports a marine production riser or loading terminal, and that serves as a structure through which to react to loads on the riser throughout its service life.

Room Temperature. Any temperature between 4°C and 40°C (40°F and 104°F) (i.e., temperature corresponding to the test conditions of the material).

Running Tool. A device used to run, retrieve, position or connect subsea equipment remotely from the surface.

Settlement. The permanent downward movement of a structure as a result of its own weight and other actions.

Shakedown. A phenomenon caused by cyclic loads or cyclic temperature distributions which produces plastic deformations in some regions of the component when the loading or temperature distribution is applied; but upon removal of the loading or temperature distribution, only elastic primary and secondary stresses are developed in the component, except in small areas associated with local stress (strain) concentrations.

Shutdown Valve (SDV). An automatically operated, fail closed valve used for isolating equipment.

Site Received Test (SRT). A test conducted to verify that the specified requirements, for a product that has been transported from one site to another, are still fulfilled.

Sour Service. Service conditions with H₂S content exceeding the minimum specified by ISO 15156 (all parts) at the design pressure.

Specified Minimum Yield Strength. The minimum yield strength at room temperature prescribed by the specification or standard under which the material is purchased.

Stress Concentration Factor (SCF). The SCF for a particular stress component and location on a tubular connection is the ratio of the hot spot stress to the nominal stress at the cross section containing the hot spot.

Stress Joint. A specialized riser joint designed with a tapered cross-section, in order to control curvature and reduce local bending stresses.

Subsea Casing Hanger. A device that supports a casing string in the wellhead at the mudline.

Subsea Isolation Valve (SSIV). An emergency shutdown valve located in the flowline that is normally installed below the splash-zone, often on the seabed.

Subsea Production Control System (SPCS). A control system operating a subsea production system (SPS) during production operations.

Subsea Safety System. An arrangement of safety devices and emergency support systems to effect the subsea system shutdown.

Subsea Umbilical Termination. A mechanism for mechanically, electrically, optically and/or hydraulically connecting an umbilical or jumper bundle to a subsea system.

Suction Pile. Typically a tall steel cylindrical structure, open at the bottom and normally closed at the top, with or without an internal stiffener system and used to support subsea structures.

Surface Controlled Subsurface Safety Valve (SCSSV). A safety device that is located in the production bore of the well tubing below the subsea wellhead and that will close on loss of hydraulic control pressure.

Surface Safety Valve (SSV). A safety device that is located in the production bore of the well tubing above the wellhead (platform well), or at the point of subsea well production embarkation onto a platform, and that automatically closes upon loss of hydraulic pressure.

Survey. An activity carried out by ABS Surveyors to determine whether an item complies with ABS requirements. May involve document review, examination, and testing as required by ABS Rules and Guides.

Sweet Service. Service conditions having an H₂S content less than that specified by NACE MR0175.

System Function Test (SFT). A test conducted to validate that the requirements for a specific intended use or application, of a set of products that form a “complete” (1) functional system, have been fulfilled.

System Integration Test (SIT). A test conducted to validate that the requirements for a specific intended use or application, of a set of products that form an integrated system, have been fulfilled.

Template. A seabed structure that provides guidance and support for drilling and includes production/injection piping.

Ultimate Tensile Strength. The maximum load before failing or breaking divided by the original cross-sectional area.

Umbilical. A group of functional components, such as electric cables, optical fiber cables, hoses, and tubes, laid up or bundled together or in combination with each other, that generally provides hydraulics, fluid injection, power and/or communication services.

Underwater Safety Valve (USV). An automatic valve assembly (installed in a subsea tree upstream of the choke) that closes upon loss of power.

Undrained Condition. The condition whereby the applied stresses and stress changes are supported by both the soil skeleton and the pore fluid and do not cause a change in volume.

Undrained Shear Strength. The maximum shear stress or shear stress at a specified shear strain, in an undrained condition.

Validation. The confirmation that the operational requirements for a specific use or application have been fulfilled, through the provision of objective evidence. Typically validation is achieved by qualification testing and/or system integration testing.

Valve Block. An integral block containing two or more valves.

Verification. The confirmation that specified design requirements have been fulfilled, through the provision of objective evidence. Typically verification is achieved by calculations, design reviews, and hydrostatic testing.

Vertical Tree. A tree with the master valve in the vertical bore of the tree below the side outlet.

Well Completion. Well operations including tubing installation, well perforation and test production.

Well Jumper. A flowline jumper located between a subsea tree and another subsea structure (typically a manifold or PLET).

Workover Riser. A jointed riser that provides a conduit from the subsea tree upper connection to the surface and allows for the passage of tools during workover operations of limited duration, and can be retrieved in severe environmental conditions.

Yield Strength. The stress level, measured at room temperature and elevated temperature, at which material plastically deforms and does not return to its original dimensions when the load is released.

15 Abbreviations

ABS	American Bureau of Shipping
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
BSDV	Boarding Shutdown Valves
BSEE	Bureau of Safety and Environmental Enforcement

CoC	Certificate of Conformity
CFR	Code of Federal Regulations
CRA	Corrosion Resistant Alloy
CSS	Classification of Subsea Systems
DRL	Design Review Letter
DSS	Duplex Stainless Steel
EFAT	Extended Factory Acceptance Test
EFL	Electrical Flying Leads
EN	European Norm
EPU	Electrical Power Unit
ESD	Emergency Shutdown
FAT	Factory Acceptance Test
FDS	Functional Design Specification
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Mode, Effects and Criticality Analysis
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HIC	Hydrogen Induced Cracking
HIPPS	High Integrity Pressure Protection System
HPHT	High-Pressure High-Temperature
HPU	Hydraulic Power Unit
I3P	Independent Third Party
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IMR	Inspection, Maintenance and Repair
IRC	Independent Review Certificate
ISIP	In Service Inspection Plan
ISO	International Organization for Standardization
ITP	Inspection and Test Plan
MAC	Manufacturer's Affidavit of Compliance
MPS	Manufacturing Procedure Specification
MRN	Maintenance Release Note
NACE	National Association of Corrosion Engineers
NDE	Nondestructive Examination
OCS	Outer Continental Shelf
OEM	Original Equipment Manufacturer
P&ID	Piping and Instrumentation Diagram
PDA	Product Design Assessment

PLEM	Pipeline End Manifold
PLET	Pipeline End Termination
PoD	Probability of Detection
PQR	Procedure Qualification Record
PR	Performance Rating
PSD	Process Shutdown
PSL	Production Specification Level
PWHT	Post Weld Heat Treatment
RCA	Root Cause Analysis
ROT	Remotely Operated Tool
ROV	Remotely Operated Vehicle
RP	Recommended Practice
SCM	Subsea Control Module
SCSSV	Surface-Controlled Subsurface Safety Valve
SEM	Subsea Electronics Module
SIF	Safety Instrumented Function
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SIT	System Integration Testing
SMYS	Specified Minimum Yield Strength
SPCS	Subsea Production Control Systems
SPPE	Safety and Pollution Prevention Equipment
SR	Survey Report
SSSV	Subsurface Safety Valves
SSV	Surface Safety Valves
SUDU	Subsea Umbilical Distribution Unit
SUTA	Subsea Umbilical Termination Assembly
SUTU	Subsea Umbilical Termination Unit
TFL	Through-Flowline
TUTA	Topside Umbilical Termination Assembly
TUTU	Topsides Umbilical Termination Unit
UPS	Uninterruptible Power Supply
USV	Underwater Safety Valve
UT	Ultrasonic Testing
WPQT	Welding Procedure Qualification Test
WPS	Welding Procedure Specification



SECTION 2 Documents to be Submitted

This Section provides the documentation submission list for Certification, Classification and I3P services on subsea production systems, subsystems, equipment and/or components during design, manufacturing, installation/commissioning, operation and decommissioning phases.

1 General

Section 2, Table 1 lists the documents to be submitted for subsea production systems, subsystems, equipment, and/or components.

- i) System level documents are listed in Subsection 2/7, while documents for subsystem/ equipment/ component level for each of the project phases are listed in Subsection 2/9.
- ii) All document submissions originating from owners/manufacturers are understood to be made with the knowledge of the main contracting party.
- iii) The actual submittal requirements are to be based on the components listed in Section 4, Table 1, which identifies the components for subsea production system, subsystem and equipment.

Note: Section 4, Table 1 is provided for general reference, and is not to be considered to be an inclusive list. For subsea production systems, subsystems, equipment and/or components not listed in Section 4, Table 1, the designer/ manufacturer should contact ABS for guidance on technical and survey requirements and completion of the approval process.

TABLE 1
Documents to be Submitted for Subsea Production Systems, Subsystems, Equipment and/or Component

		Design	Manufacturing			Installation/ Commissioning	Operation	Decommissioning (For I3P Service)
			Materials, Welding, NDE	Fabrication	Testing			
System		X	-----	X	X	X	X	X
Subsystem	Injection System	X	X	X	X	X	X	X
	Service System	X	X	X	X	X	X	X
	Electrical System	X	X	X	X	X	X	X
	Control and Monitoring System	X	X	X	X	X	X	X
Equipment	Wellhead	X	X	X	X	X	X	X
	Tree and Tubing Hanger	X	X	X	X	X	X	X
	Flowline, Jumper and Riser	X	X	X	X	X	X	X
	HIPPS	X	X	X	X	X	X	X
	Manifold, PLEM/PLET and Template	X	X	X	X	X	X	X
	Umbilical/ Flying Lead	X	X	X	X	X	X	X
	Capping Stack	X	X	X	X	X	X	X
	Flow Meter	X	X	X	X	X	X	X
	ROV/ROT Interfaces	X	X	X	X	X	X	X
	Foundation	X	X	X	X	X	X	X
	Protection Structure	X	X	X	X	X	X	X
Component		See Section 4, Table 1	X	X	See Section 4, Table 1	-----	-----	-----

Note: X – Documents review is required.

3 Design and Manufacturing Specifications

3.1 Design Specification

Design specification for subsea production systems, subsystems, equipment and/or components is to include:

- i) Functional requirements
- ii) Environment (metocean, soil, internal fluid) data
- iii) Loading conditions and associated load case matrix
- iv) Pressure and temperature rating
- v) Interface with other subsystem/equipment
- vi) Applicable codes and standards

3.3 Manufacturing Specification

Manufacturing specification for subsea production systems, subsystems, equipment and/or components is to include:

- i) Quality plan and specifications
- ii) WPSs, PQRs and weld maps
- iii) NDE procedures and maps
- iv) Detailed Inspection and Test Plans (ITPs), including associated test procedures
- v) Installation and Commissioning plans and procedures

5 General Arrangement for Subsea Production System

General arrangement plans are to be submitted to ABS for review, including the following information, as applicable:

- i) *System/Subsystem Level.* General arrangement of the installation/equipment as listed in 1/7.3 where the subsea production system/subsystem and its equipment are installed.
- ii) *Equipment Level.* Equipment layout, detailed arrangements and elevation drawings showing:
 - Locations of all equipment and structures for subsea operations
 - Piping systems associated with the subsea production systems, and support systems
 - Locations of all control panels/stations for subsea production systems, including all subsea support systems

7 System Level Documents to be Submitted for Review

The following documents for subsea production systems are to be submitted for ABS review, as applicable:

- i) Design basis, including but not limited to
 - Descriptions of the subsea production systems
 - Descriptions of each equipment including major components
 - Design specifications (see 2/3.1)
 - Analysis methodology for subsea production system design
- ii) Master equipment list
- iii) Field layout drawing including equipment

- iv) Assembly drawings, diagrams and schematics (including for equipment, piping and instrumentation diagrams/drawings (P&IDs), hydraulic, electrical and control schematics)
- v) Cause and effect chart
- vi) HAZID and/or HAZOP study reports for the entire subsea production systems and all associated subsystems
- vii) FMEA/FMECA or similar analysis, and its validation program for integrated systems
- viii) Safety principle and philosophy
- ix) System Integrity Test (SIT) procedure and report

9 Subsystem/Equipment/Component Level Documents to be Submitted for Review

9.1 Design Documents

9.1.1 Design Documents for Subsystem/Equipment/Component

The following documents are to be submitted to ABS for review, as applicable. Flowline and riser documentation requirements are to follow the *Pipeline Guide* and *Riser Guide*, respectively. For documentation for Electrical and Control Systems, see 2/9.1.2.

- i) Design basis, including
 - Design specifications (see 2/3.1)
 - P&IDs and schematic diagrams
 - Design analysis methodology, procedures and load case matrices
 - Manufacture and installation tolerances
 - Specification of the internal fluid
 - Corrosion/erosion allowances for piping
- ii) Bill of material
- iii) Material specifications, properties and traceability
- iv) Drawings of arrangement, stack-up, scope of supply, assembly, interface, and marking, as appropriate
- v) *Analysis Reports.* Any analysis required by applicable codes and standards as listed in this Guide as a minimum is to be included to verify the integrity of the equipment for all design conditions as listed in 3/1.7 as applicable
- vi) Weights report including centers-of-mass for equipment
- vii) FMEA/FMECA or similar analysis, and its validation program
- viii) Corrosion control and protection details
- ix) Manufacturer's affidavit of compliance (see 4/3.1.2)
- x) Site geotechnical/ geophysical reports

9.1.2 Design Documents for Electrical and Control System

The following documents for subsea electrical and control system are to be submitted to ABS for review, as applicable

- i) Functional Description Document (FDD) for control and instrumentation equipment
- ii) Control system details
 - Details on hierarchy of controls: primary, secondary, emergency, etc.
 - Details and description of interconnections between control systems

- Primary power source and emergency power source details
 - Volumetric capacity calculations for the accumulator systems, primary and secondary
 - Hydraulic power unit (HPU) details/arrangements
 - Pump system details and arrangements
 - Prime mover details
 - Reservoir capacity and arrangements
 - Hydraulic and electrical schematics
 - Pressure relief system
 - Arrangements
 - Size
 - Materials
 - Back pressure and capacity calculation
 - Manufacturing/inspection/test specifications
- iii) Design and details of subsea control system fail-safe principle, and FMEA/FMECA study
- iv) Document on safety integrity levels (SIL) in accordance with IEC 61508 and alarm classification
- v) Shutdown logic and/or shutdown (including ESD and PSD) cause and effect charts
- vi) Drawings and schematics, including
- Arrangement drawing showing location and/or deployment of units controlled, instrumentation and control devices and set points for control system components
 - Arrangements and details of topside control consoles/panels (e.g. MCC, MCS, HTP, etc.), including front views, installation arrangements together with schematic plans and logic description for all power, control and monitoring systems, including their functions
 - Type and size of all electrical and/or fiber optic/signal cables and wiring associated with control systems (e.g., surface to surface, surface to subsea, and subsea to subsea), including voltage rating, service voltage, maximum acceptable voltage drop and currents, together with overload and short-circuit protection, conductors materials and dimension, insulation and external metallic protection specification, cable grounding as applicable, and the standards/codes the design is referenced to or is in compliance with
 - Schematic plans and logic description of hydraulic and electrical control systems together with all interconnections, piping sizes and materials, including working pressures, relief-valve settings, and end connector/pull-in head/bend restrictor
 - Description of all alarm and emergency tripping arrangements and functional sketches or description of all special valves, actuators, sensors and relays
- vii) Design report, including:
- Calculations for control systems demonstrating the system's ability to react adequately to anticipated occurrences, including transients, minimize well shut-down, disruption to the operations and production losses due to unexpected failures on any subsea controls system component or subsystem

- Details for external/internal corrosion protection (e.g., cathodic protection, and corrosion allowance) of subsea control components and equipment
- Design specifications for electrical communication system and protocol, and/or hydraulic analysis for hydraulic supply and confirming system response time, as applicable
- Design specifications for control valve/choke valve, chemical/methanol dosing requirements, and scale inhibitor system
- Design specifications for electrical jumper and connector, hydraulic/chemical jumper and connector, and umbilical/flying lead/jumper installation arrangement as applicable
- Design specifications for subsea electronic modules' (SEM) hardware, software, and instrumentation
- Design specifications for surface controlled subsurface safety valve (SCSSSV)
- viii) Hydrocarbon detection system plans and data, including detectors, piping, set points, type of detectors, and location of alarm panels
- ix) Computer-based systems plans and data
- x) Control system operating and maintenance manuals (including subsea control equipment maintenance and repair access/lift up arrangement and/or other intervention plan)

9.3 Manufacturing Documents

9.3.1 Materials, Welding and NDE

Materials used for pressurized members, load bearing (structural and/or mechanical) members, and threaded fasteners, are to be furnished with material manufacturer/mill's documentation (e.g., material test reports (MTR), etc.) stating as a minimum, the following, as applicable

- i) Certification by the material manufacturer/mill of compliance with the applicable recognized material specification or manufacturer's written specification
- ii) Material specification, grade
- iii) Process of manufacture, including melting practices, reduction ratio
- iv) Product heat number/batch number
- v) Chemical analysis, with tolerance ranges and testing standard(s)
- vi) Heat treatment records (showing heat treatment times at temperatures, heating and cooling rate, quenching media, transfer time, photographic evidence of components in furnace showing compliance to the furnace loading diagram, heat treating equipment)
- vii) Re-heat treatment information
- viii) Mechanical properties, including acceptance criteria:
 - Tensile properties and testing standard(s)
 - Charpy impact values and temperatures, including testing standard
 - Hardness test readings (according to NACE MR0175/ISO 15156 standards), including testing standards
- ix) Surface treatment information: evidence of surface hardening, coating, plating, thermal spraying, cladding, insulation, etc., to show compliance with the material specification
- x) Dimension report
- xi) WPSs, PQRs and weld maps
- xii) NDE procedures and maps
- xiii) NDE results including acceptance and rejection criteria

- xiv) Corrective actions and disposition of major non-conformances during the material manufacturing or forming process
- xv) In case repair welding is permitted, weld repair map and associated documentation is to be included
- xvi) Material storage requirements

9.3.2 Fabrication Documents

The following fabrication documents for subsea equipment during manufacturing phase are to be submitted to ABS for review, as applicable

- i) Manufacturing and quality control documents
- ii) Fabrication details and procedures (structure fabrication procedure, heat treatment, dimension control, etc.)
- iii) Manufacturer databook
- iv) Detailed Inspection and Test Plans (ITPs) for manufacturing phase including associated test procedures for system, subsystem, equipment or component, as outlined in Section 4, Table 1, as applicable

9.3.3 Testing Documents

The following documents for testing of subsea equipment during manufacturing phase are to be submitted to ABS for review, as applicable

- i) Testing procedure including testing specification, acceptance criteria, testing tools and equipment used, along with calibration data
- ii) Testing reports for validation testing, FAT, EFAT

9.5 Installation/Commissioning Documents

The following documents during the installation/commissioning phase are to be submitted to ABS for review, as applicable

- i) Detailed Inspection and Test Plans (ITPs) for installation/commissioning phase
- ii) SIT procedures and reports
- iii) Installation manual including deployment, abandonment and retrieval
- iv) Lifting arrangement
- v) Installation analysis report per applicable codes and standards if it is not reviewed at the design phase
- vi) Post-installation survey report
- vii) Contingency procedures

9.7 In-service Documents

The following documents are to be submitted to ABS

- i) In Service Inspection Plan (ISIP)
- ii) Repair and replacement plan, as identified by the inspection
- iii) Maintenance documentation

9.9 Life Extension Documents

The following documents for life extension of subsea structures during operation life management phase are to be submitted to ABS for review, as applicable

- i) Inspection and test record
- ii) An application document to propose life extension of the subsea structure including
 - Proposed continuing operation life
 - Proposed continuing operation conditions including environmental conditions
 - Inspected structure condition
 - Environmental/geotechnical condition changes record
 - Corrosion history, predicted corrosion rate and predicted end of life condition
 - Proposed repair and replacement
 - Future inspection/monitoring plan, inspection interval and acceptance criteria
 - Proposed testing plan including pressure limits and testing interval
- iii) Analysis reports for life extension of the subsea structure including
 - Strength assessment per inspected condition
 - Fatigue damage accumulated based on previous operation history
 - Strength analysis for the structure per structure and system condition at the end of proposed life extension, under proposed the worst environmental condition, considering proposed repair and replacement
 - Remaining fatigue life per inspected condition and predicted corrosion under proposed continuing operating conditions considering proposed repair and replacement

9.11 Decommissioning Phase (for I3P service)

The following documents during decommissioning phase are to be submitted to ABS for review, as applicable:

- i) Decommissioning basis including applicable codes and standards
- ii) Documents defining the scope of work for decommissioning
- iii) Decommissioning manual and procedure
- iv) Lifting arrangement
- v) Retrieval analysis report similar to the installation report in 2/9.5v)



SECTION 3 Requirements for Classification/Certification

This Section provides the general design considerations and requirements for Classification/Certification of subsea production systems, subsystems, equipment and/or components. The maintenance of classification during the service lives of subsea production systems/subsystems is dependent upon meeting the requirements contained herein for periodical surveys as specified in Section 6 in this Guide.

The general design considerations and general design requirements are outlined in Subsections 3/1 and 3/3, respectively. Detailed requirements for each subsystem/equipment are specified in 3/5.1 to 3/5.27, while 3/5.29 summarizes the governing API standards for each subsystem/equipment listed in 3/5.1 to 3/5.27.

1 General Design Considerations

1.1 Recognized Standards

The design of subsea production systems, subsystems, equipment and/or components is to be in accordance with the requirements of this Guide and the latest edition of the specified codes and standards, as referenced herein and in Appendix 2, based on the project contract date or request for class signed date.

- i) Designs complying with other international or national standards not listed in Appendix 2 will be subject to special consideration in accordance with 1/7.5.
- ii) ABS recommends that the designer/manufacturer contact the ABS Technical office early in the design phase for acceptance of alternate design codes and standards.
- iii) When alternate design codes and standards are proposed, justifications can be achieved through equivalency, gap analysis or appropriate risk analysis to demonstrate that the proposed alternate design code and standard will provide an equivalent level of safety to the recognized standards as listed in this Guide, and are required to be performed in accordance with 1/7.7.

1.3 Alternative Basis of Design

Designs based on manufacturers' standards may also be accepted. In such cases, complete details of the manufacturer's standard and engineering justification are to be submitted for review.

- i) The manufacturer will be required to demonstrate by way of testing or analysis that the design criteria employed results in a level of safety consistent with that of a recognized standard or code of practice.
- ii) Where strain gauge testing, fracture analysis, proof testing or similar procedures form a part of the manufacturer's design criteria, specifics of the procedure and results are to be submitted for ABS review.
- iii) Historical performance data for subsea production systems, subsystems, equipment and/or components is to be submitted for justification of designs based on manufacturers' standards.
- iv) ABS will consider the application of risk evaluations for alternative or novel features for the basis of design in accordance with 1/7.7, as applicable.

1.5 Risk Assessments for Subsea Production Systems

All hazards that may affect the subsea production system or any of its subsystems, equipment, and/or components are to be properly identified and risks managed to a tolerable level with implementation of effective risk control options. A systematic process is to be applied to identify situations where a combination or sequence of events could lead to undesirable consequences (property damage, personnel safety and environmental damage), with consideration given to all reasonably foreseeable causes.

The identified risk control options (prevention and mitigation measures) deemed necessary to be implemented are to be considered part of the design basis of the subsea production system.

Appendix 4 in the *ABS Guide for Risk Evaluations for the Classification of Marine-Related Facilities* contains a description of the most common hazard identification techniques. Also, Appendix 2 in the same Guide provides an overview of how to assemble an appropriate risk assessment team.

1.5.1 Hazard Identification (HAZID)

A HAZID study is to be conducted for the overall subsea production system. ABS' participation in this HAZID study is required.

1.5.2 FMEA/FMECA

The purpose of a FMEA is to verify that the individual subsea production systems, subsystems and equipment comply with the following design philosophy:

- i) No single failure will lead to a hazardous situation to people, environment or equipment, and
- ii) That there are at least two means of protection in place to prevent the hazardous event.

A functional FMEA/FMECA is to be conducted for individual systems, subsystems and their associated control systems and submitted for review. Based on the results of functional FMEA/FMECA, a component level FMEA/FMECA may be deemed necessary to be performed for the critical components as identified during the functional FMEA/FMECA.

If component level FMEA/FMECA is required, the results of the component level FMEA/FMECA is to correlate to the functional FMEA/FMECA to provide an overall understanding of the local effects of the equipment failure mode and 'global' effects of the failure of the control/safety function and other equipment/interfaces in the system.

Functional FMEA/FMECA and component level FMECA can be conducted in accordance with API RP17N, the *ABS Guidance Notes on Qualifying New Technologies* and the *ABS Guidance Notes on Failure Mode and Effects Analysis (FMEA) for Classification*.

A FMEA/FMECA Validation Program and related test procedures are to be developed and submitted for review. The purpose of the FMEA/FMECA Validation Program is to verify critical and selected results (that are not already covered by FAT and SIT procedures) from the FMEA.

The specific goals of the tests are to validate the:

- Effectiveness of system to identify failures
- Effect of identified failures on system/equipment
- Response of safety controls
- Other measures to protect against failure

Validation tests are to be carried out during factory acceptance testing and/or as part of the onboard commissioning of the integrated systems in accordance with the approved program and verified by the attending Surveyor.

When final testing requires assembly and installation on-board the facility, it may not be possible to perform all required testing at vendor's plant. In this case, FMEA/FMECA Validation testing is to be carried out as part of the system integration testing (SIT) during commissioning. Any modifications made to the Validation test plan are to be submitted for review.

7/1.11 of the *ABS Guidance Notes on Failure Mode and Effects Analysis (FMEA) for Classification* provides detailed steps for the FMEA/FMECA and FMEA Validation Program.

1.7 Design Loading Conditions

Design loading conditions typically include:

- i) Normal operations
- ii) Extreme operations
- iii) Accidental/survival
- iv) Temporary loading conditions including:
 - Testing
 - Transportation
 - Drilling and/or completion
 - Installation
 - Well intervention
 - Decommissioning

See Subsection 1/13 for the definitions of the above loading conditions.

Safety/design factors for each structure item of subsea subsystem/equipment are to follow applicable codes and standards.

Serviceability requirements that limit the potential for unsatisfactory performance of the equipment are to be verified for the equipment/component when subject to the design loads (see Section 3, Table 1). Serviceability requirements include limits on the displacement (including translation, rotation and deflection) and deformation of a component which may cause operational concerns such as leakage, functional performance capability, and interference with adjacent structures and equipment. The serviceability requirements are to be specified in the Design Specification (see 2/3.1).

Serviceability requirements for each item of subsea subsystem/equipment are to follow applicable codes and standards.

1.9 Design Load Types

1.9.1 Load Types

Each loading condition listed in 3/1.7 for design of a subsea production system or equipment is to include one or a combination of the following load types, as applicable:

- Environmental loads
- Accidental loads
- Functional loads

1.9.1(a) Environmental Loads. Environmental loads are defined as loads imposed directly or indirectly by metocean forces and soil movements etc. as listed in Section 3, Table 1. In general, the environmental loads vary with time and include both static and dynamic components. The characteristic parameters defining environmental loads are to be appropriate to the project phases.

1.9.1(b) Accidental Loads. Accidental loads are defined as loads that occur accidentally due to abnormal operating conditions, technical failure, human error and environmental condition with an annual probability of occurrence less than 10^{-2} as listed in Section 3, Table 1. Dynamic effects are to be properly considered when applying accidental loads to the design. Risk-based analysis and past experience may be used to identify the frequency and magnitude of accidental loads. The dropped-objects and fishing-gear loads should be estimated by using recognized codes and standards, such as Datasheet No. F5 in Annex F of API RP 17A.

1.9.1(c) Functional Loads. Functional loads include loads due to the flow, weight, pressure, temperature, and boundary condition-induced loads as listed in Section 3, Table 1.