Table A.96 — Equipment subdivision — Subsea pumps

Equipment unit	Subsea pumps [a]				
Subunit	**Pump**	**Electric motor**	**Barrier fluid [b, c]**	**Control and monitoring**	**Miscellaneous**
Maintainable items	Bearing, radial Bearing, thrust Casing Connector Cylinder liner Impeller Piping Piston Seal Shaft Structure, protect Structure, support Mechanical landing interface Valve, control Valve, process isolation Valve, other	Bearing, radial Bearing, thrust Casing Connector Control unit Impeller Rotor Seal Stator Support Subsea electrical penetrator	Accumulator Hydraulic coupling Cooling Filter Lubrication oil Piping Lubrication oil pump incl. driver Reservoir Valve, check	Cable Junction box Leak sensor Level sensor Power supply Pressure sensor Power/signal coupler Speed sensor Temperature sensor Vibration sensor Valve, other	Connector Cooling/heating Piping Pulsation damper Purge system

[a] Note that the subsea pump includes the driving unit (electric motor) as opposed to the pumps located topsides or onshore (See A.2.2.6). The subsea pump does not include power transmission to the (subunit) electrical motor, as this will be covered by the equipment class "Subsea electrical power distribution". It should also be noted that the equipment class "Subsea pumps" does not include "Submersible pumps" located in a seafloor caisson.

[b] The barrier fluid equipment has four main functions:

— electric isolation (dielectric properties);

— lubrication of bearings and seals;

— ability to transport away heat;

— ability to transport particles to possible filter systems.

[c] The maintainable items are primarily located topsides, but some also subsea (e.g. hydraulic couplings in either end of umbilical).The barrier fluid is distributed from topsides (or from onshore) to the subsea pump via barrier fluid lines which are inside static umbilical (and possibly dynamic umbilical) and possibly via hydraulic jumpers. This equipment is defined as subunit and maintainable items within the equipment class "Subsea production control" (See A.2.6.1). Depending on the field infrastructure where the subsea pump is located, these umbilicals can already be defined. The items may be included as part of the overall barrier fluid distribution and thus added as maintainable items in the subunit "Barrier fluid", to ensure precise reliability data collection/estimation. See also similar issues regarding electric power supply in the note (a) above.

Table A.97 — Equipment-specific data — Subsea pumps

Name	Description	Unit or code list	Priority
Well identification number	Operator description	Number or name	High
Discharge pressure – design	—	Pascal (barg.)	High
Suction pressure – design	—	Pascal (barg.)	Medium
Pump driver	Type of driver	Electric motor, turbine, hydraulic motor	High
Power – design	Driver power	Kilowatt	High
Speed	Design value	Revolutions per minute	Low
Number of stages	—	Number	Low
Pump coupling	—	Fixed, flexible, hydraulic	Low
Manufacturer	Specify	Specify	High
Model type	Specify	Specify	Low
Pump design	Design characteristic	Axial, radial, composite, diaphragm, plunger, piston, screw, vane, gear, lobe	High
Application - pump	Where applied	Booster, injection, active cooling	Medium
Fluid handled	Main fluid only: oil, gas, condensate, injection water	Oil, gas, condensate, injection water, oil and gas, gas and condensate, oil/gas/water, CO_2, gas and water, produced water, cooling medium	High
Fluid corrosiveness	Classify as shown in footnote [a]	Neutral, sweet, sour	High
Radial bearing type	Specify	Magnetic, roller, sliding	Low
Thrust bearing type	Specify	Magnetic, roller, sliding	Low
Shaft orientation	Specify	Horizontal, vertical	Low
Shaft seal type	Specify	Dry, gland, labyrinth, mechanical, oil, packed combined	Low
Transmission type	Specify	Direct, gear, integral	Low

[a] Neutral (clean fluids with no corrosive effects).

Sweet [moderately corrosive/erosive (oil/gas not defined as severe, raw sea water, occasional particles)].

Sour {severely corrosive/erosive [sour gas/oil (high H_2S), high CO_2, high sand content]}.

A.2.6.5 Subsea electrical power distribution

Electrical power distribution system specifically excludes subsea control system power distribution. Electrical power distribution is dedicated for distribution to subsea processing equipment (e.g. multi-flow pumps, water injection pumps, and compressors) with power requirements in range MW. The electric power to control and instrumentation is part of the equipment class “Subsea production control” - see A.2.6.1.

If the electric power comes directly from onshore, the subunit “Static power cable” in A.2.6.5 will apply, and would be similar as subunit “Static power cable” in an equipment class “Submarine power cable” used for providing power from shore to offshore facility (and may have an associated dynamic power cable, if an offshore floating facility). The topsides power distribution equipment will in the former case be located onshore. The equipment class “Submarine power cable” is not currently included in this annex.

Table A.98 — Type classification — Subsea electrical power distribution

Equipment class — Level 6		Equipment type	
Description	**Code**	**Description**	**Code**
Subsea electrical power distribution	EP	Single consumer without subsea step- down	SU
		Single consumer with sub-sea step- down	SD
		Multiple consumer	MC

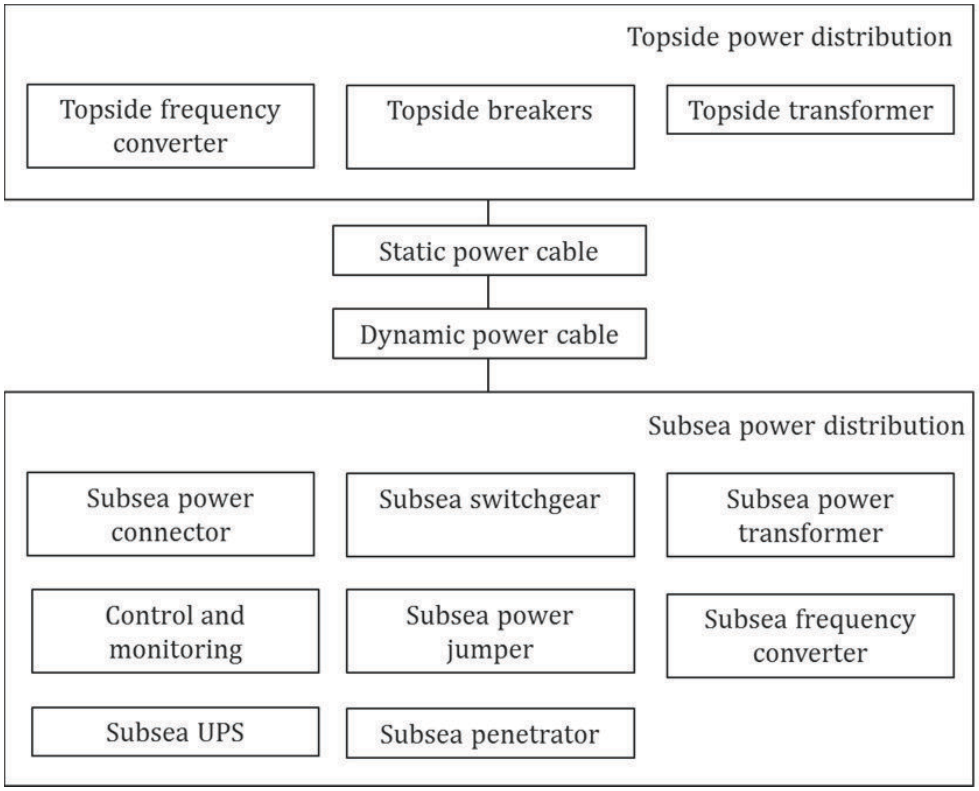

Figure A.34 — Boundary definition — Subsea electrical power distribution

Table A.99 — Equipment subdivision — Subsea electrical power distribution

Equipment unit	Subsea electrical power distribution			
Subunit	**Topside power distribution equipment**	**Dynamic power cable [a]**	**Static power cable [b]**	**Subsea power distribution equipment [j]**
Maintainable items	(No subdivision) [l]	Topside cable termination unit Tension & motion compensation equipment Bend restrictor Buoyancy device J/I-tube seal Stabilizer [c] Subsea cable termination unit Midline joint Sheath/armour HV power line Fibre-optic line [o]	HV power line Fibre-optic line [o] Factory joint Offshore joint Sheath/armour Subsea cable termination unit Topside cable termination unit [h] Onshore cable termination unit Bend restrictor Midline joint	Subsea power connector [n] Subsea switchgear [e] Subsea power transformer [g] Subsea penetrator [f] Subsea frequency converter [d] Subsea power jumper [j] Subsea UPS [i] Control and monitoring [m]

[a] Similar components as for the subunit Dynamic umbilical for the equipment class Subsea production control.

[b] Similar components as for the Static umbilical Subunit for equipment class Subsea production control equipment class.

[c] Anchor clamp/anchorage is part of the stabilizer.

[d] Note regarding the level of detailing. A subsea frequency converter includes subsea penetrators, and can contain contactors. However, precision needs to be dealt with in use for reliability data collection or estimation. Subsea frequency converter can be of type "pressure compensated" or "non-pressure compensated".

[e] The maintainable item *Switchgear* will also include parts subsea protective devices.

[f] Subsea penetrators are either electrical (LV power/signal), electrical (HV) or fibre-optic penetrators. This needs to be reflected for equipment specific data on maintainable item level.

[g] Note the difference between subsea transformer as maintainable item (Level 8) and topsides Power transformer (Equipment class – level 6, as given in A.2.4.2).

[h] Applies if subsea static power cable tie-back to fixed installation.

[i] This MI may be given further special detailed attention in reliability data collection or estimation by using Annex A.2.4.1 UPS.

[j] Subsea power jumper inside the subunit "Subsea power distribution equipment" can only be electrical (HV). However, inside an "overall subsea power distribution system", also LV power/signal jumper (being electrical (LV power/signal)), or fibre-optic jumper exist. These two maintainable items appear in the taxonomy for "Subsea production control" in Table A.87, and possibly others would also be relevant, e.g. hydraulic/chemical lines may sometimes be also part of the dynamic and static power cable. Rather than introducing more subunits in Table A.99, one can use those components (appearing in various subunits) in Table A.87 that is in this case relevant for subsea power in conjunction with a reliability data collection. Note also that LV power/signal lines in dynamic & static umbilicals are not part of the equipment class "Subsea electrical power distribution", but in the Annex A.2.6.1 "Subsea production control". If subsea power cable also includes (is bundled with) hydraulic/chemical lines and power/signal lines, it is recommended to register data onto the subsea power cable.

[k] Generally, it is important to be aware of that some maintainable items (e.g. subsea penetrator and pressure compensator) in Subsea EPD can appear as parts (Level 9) in different MIs. Attention to this matter is needed in reliability data collection and estimation. Subsea contactor is for example not included as a maintainable item, as this would require also other components like current transformer, voltage transformer that are part of larger units like a subsea frequency converter or a switchgear

[l] The topside power distribution equipment (*) is not further subdivided as it will be covered by other equipment classes defined in this International Standard. It should be noted that equipment classes Frequency converter (topsides - ref. A.2.4.4)" and Power transformer (topsides- ref A.2.4.2) are such equipment (*), the configuration of power transformer depends on if subsea power transformer is used subsea. Equipment class *Switchgear* (which would include topsides protective device) is also part of such equipment (*). In addition, reactive compensation equipment will exist when long subsea power cable to offshore facility or power directly from shore.

[m] The control and monitoring associated with subsea electric power distribution equipment is included in the subunit. This comes in addition to the local control and monitoring for e.g. subsea pumps – see A.2.6.4.

[n] The Subsea power connector is sometimes called the HV connector, and can be dry or wet mate. Note that the electrical (LV power/signal), and fibre-optic connectors used for Subsea Power Distribution are covered by these maintainable items in Subunit "Subsea distribution module" in the taxonomy for equipment class "Subsea production control" in Table A.87.

[o] During data collection precision is required to ensure sufficient information is captured enabling differentiation between failures affecting single fibre and failures affecting multiple fibres/bundle of fibres.

Table A.100 — Equipment-specific data — Subsea electrical power distribution

Name	Description	Unit or code list	Priority
Transmission voltage [a]	0 – 9,999	kV	High
Transmission power	0 – 99,999	kVA	High
AC/DC	AC DC AC/DC	Codes	High
Transmission distance	0 - 999	km	High
Number of power consumers	0 - 99	#	High
Type of power consumers	Type of power consumers	Subsea pump, subsea compressor, subsea heater, subsea cooler	High

[a] Voltage is given in steps, as per IEC 60038:2009 (see below).

— LV < 1kV

— MV 1 to 35kV

— HV 35 to 230kV

— EHV above 230kV

The international oil & gas industry may use different definition with respect to Extra High Voltage (EHV), High Voltage (HV), Medium Voltage (MV) and Low Voltage (LV). Reference to IEC versus IEEE/ANSI needs to be considered here to know e.g. voltage range for HV as they may be categorized differently. For other than low voltage (LV), i.e. > 1KV special national electrical regulations will apply due to HSE reasons.

A.2.6.6 Subsea pressure vessels

Table A.101 — Type classification — Subsea pressure vessels

Equipment class – Level 6		Equipment type	
Description	**Code**	**Description**	**Code**
Subsea pressure vessels	SV	Coalescer	CA
		Cyclone	CY
		Hydrocyclone	HY
		Scrubber	SB
		Separator	SE
		Slug catcher	SC
		Surge drum	SD

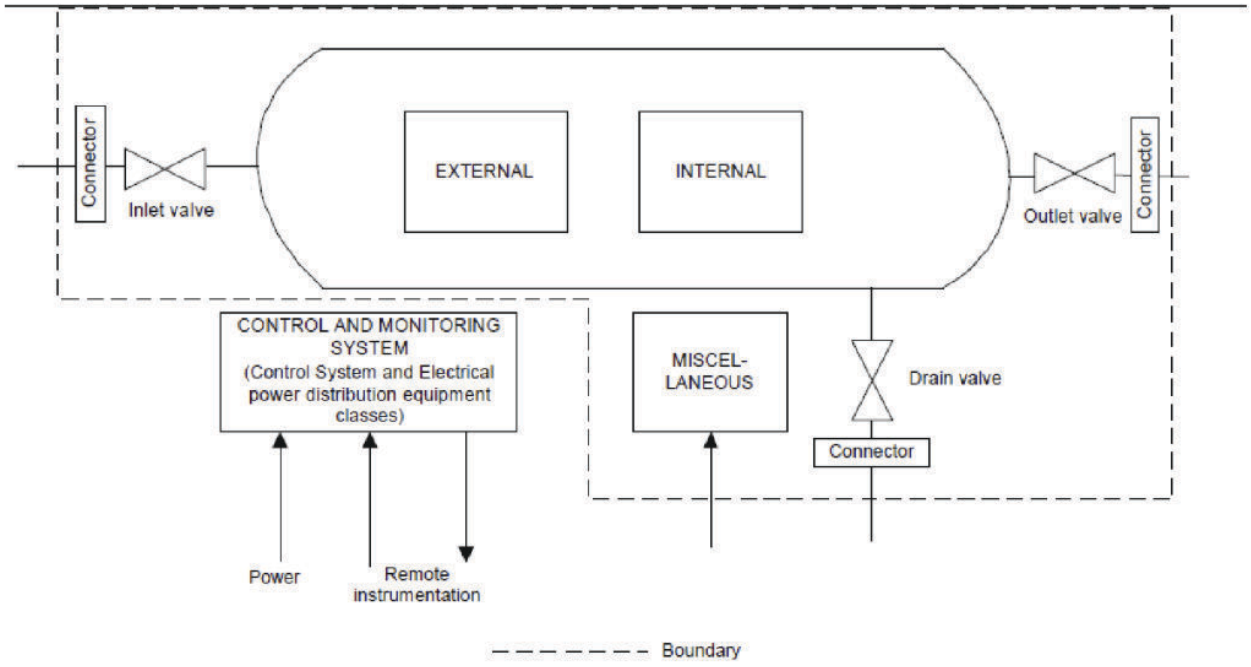

Figure A.35 — Boundary definition — Subsea pressure vessels

Table A.102 — Equipment subdivision — Subsea pressure vessels

Equipment unit	Subsea pressure vessels			
Subunit	**External items**	**Internal items**	**Control and monitoring [c]**	**Miscellaneous**
Maintainable items	Protective structure	Coalescer plates	Sensors [a]	Others
	Support structure	Baffle plates	Valve, control	
	Insulation	Trays		
	Connector	Vanes		
	Body/Shell	Pads		
	Piping [b]	Demister		
	Valve, check	Diverter		
	Valve, process isolation	Grid plate		
	Valve, utility isolation	Heat coil		
	Valve, other	Sand-trap system		
		Distributor		

[a] Subsea sensors would also be covered in the Subunit "Sensors" for equipment class "Subsea production control" (See Table A.87). Such sensor would include "Multiphase meters", "Oil in water" sensor, "Water in oil" sensor and "Fluid level sensor". See also A.2.5.2 Input devices which describe a specific equipment class, but is meant for non-subsea applications, but may be relevant also for reliability data collection/estimation.

[b] Hard pipe.

[c] Control and monitoring for "Subsea pressure vessel" will be similar, but somewhat different from topsides/onshore "Pressure vessel" (see Table A.39): LV power/signal jumper and LV power/signal connector will be analogue to wiring and piping, but is covered by the subunit "Subsea distribution module" (See Table A.87).

Table A.103 — Equipment-specific data — Subsea pressure vessels

Name	Description	Unit or code list	Priority
Equipment application	Where used	Oil processing, Condensate processing, Gas (re-)injection Gas processing, Gas treatment, Water (re-)injection, Liquid/gas separation, Liquid/Gas/Solid separation	High
Retrievable	Retrievability of the subsea pressure vessel	Yes/No	High
Fluid erosiveness	Classify as shown	Clean, benign , moderate, severe	High
Fluid corrosiveness	Classify as shown	Neutral, Sweet, Sour	High
Fluid(s)	Main fluid	Gas/oil/water, gas/oil, gas/condensate, oil/water, oily water, water/glycol, methanol, chemicals	High
Liquid/gas boosting		Yes/No	Medium
Pressure - operating	Specify	Pascal (bar)	Medium
Design pressure	Specify	Pascal (bar)	High
Design temperature	Specify	Degrees Celsius	High
Temperature - operating	Specify	Degrees Celsius	Medium
Retention time	Specify	Minutes	Medium
Design throughput	Specify	Sm3/d	Medium
Size - diameter	External	Metres	Medium
Size - length	External	Metres	Medium
Orientation	Specify	Horizontal, vertical, spherical	Medium
Body material	Specify type or code	Free text	Low
Sand production	Specify	Yes/No	Low
Emulsions	Specify	Yes/No	Low
Hydrate formation	Specify	Yes/No	Low
Wax formation	Specify	Yes/No	Low
Scale formation	Specify	Yes/No	Low
Asphaltenes	Specify	Yes/No	Low
NOTE The equipment specific data for “Subsea pressure vessel” is similar, but also somewhat different from for a topsides/onshore “Pressure vessel (See Table A.40) due to that the pressure vessel is located at the seabed.			

A.2.6.7 Subsea pipelines

Subsea pipeline transportation system covers:

— export pipeline systems between subsea well facilities (“export manifold”) and onshore terminal;

— export pipeline systems between offshore processing facilities and other offshore processing/export facilities (subsea intra-field pipelines);

— export pipeline systems between offshore facilities and onshore terminal;

— intercontinental export pipelines, between onshore terminal and another onshore terminal;

— export lines to offshore offloading systems.

The onshore part of a subsea pipeline is covered by this equipment class “Subsea pipelines”, and valves would be located subsea and/or onshore.

The in-field flowlines (with e.g. well flow, injection gas or injection water) between subsea wells and offshore processing facilities, or onto “export manifold”, are covered by the equipment class “Subsea flowlines”.

Table A.104 — Type classification — Subsea pipelines

Equipment class – Level 6		Equipment type	
Description	**Code**	**Description**	**Code**
Subsea pipelines	SL	Flexible	FL
		Rigid	RI

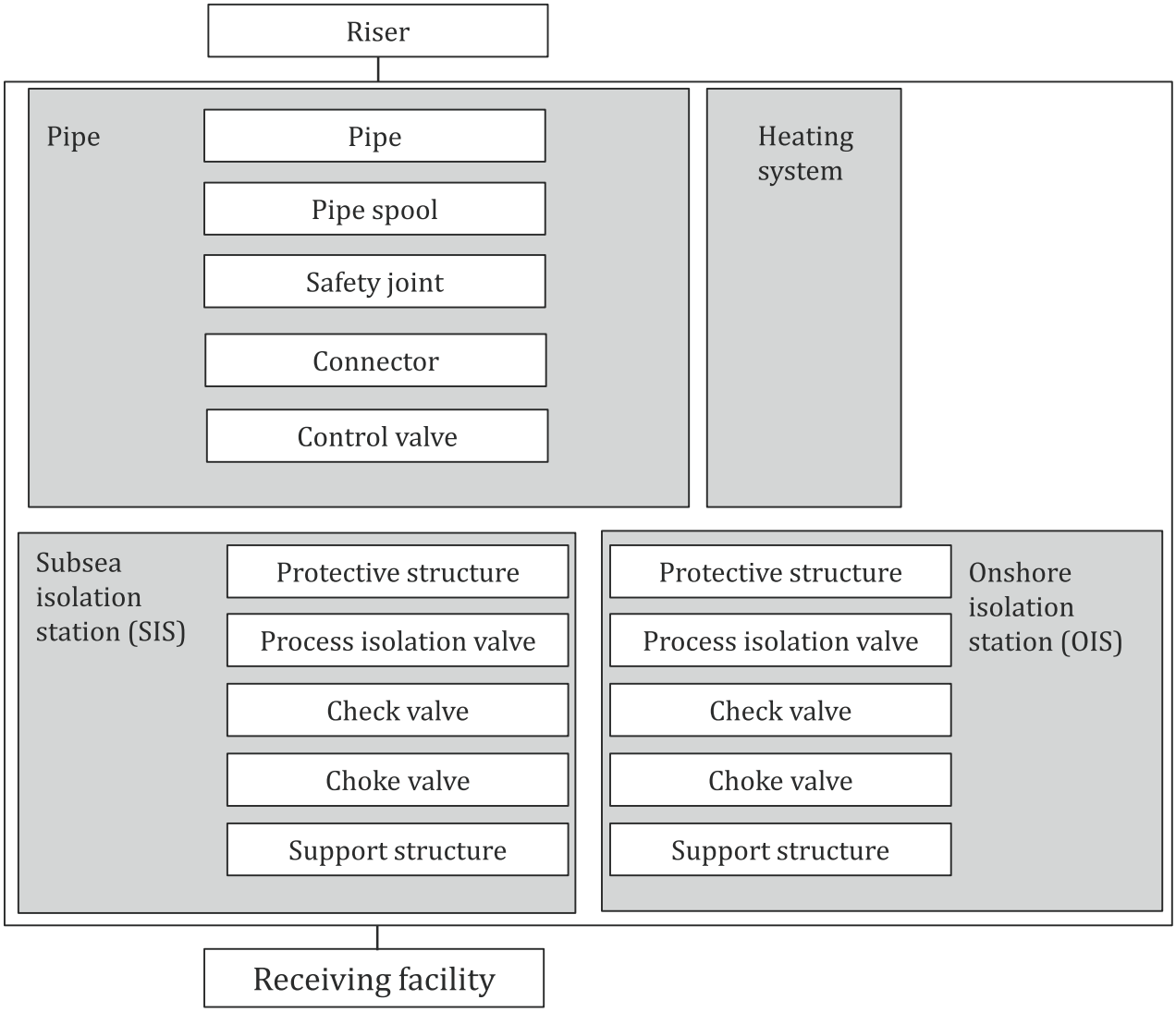

Figure A.36 — Boundary definition — Subsea pipelines

Table A.105 — Equipment subdivision — Subsea pipelines

Equipment unit	Subsea pipelines			
Subunit	**Pipe**	**Heating system [a]**	**Subsea Isolation Station (SIS) [b]**	**Onshore Isolation Station (OIS) [b]**
Maintainable items	Coating external	Subsea part	Structure - protective	Structure - protective
	Connector	Topsides part	Structure - support	Structure - support
	Sealine		Valve, process isolation [c]	Valve [f], process isolation
	Safety joint		Valve, utility isolation	Valve, utility isolation
	Flexible pipe spool		Valve, check	Valve, check
	Rigid pipe spool		Valve, control	Valve, control
	Valve, process isolation [d]		Pig station [e]	Pig station [e]

[a] The heating system would normally not apply for long distance pipeline (trunkline) transport systems. In general heating system is used in in-field flowlines for non-processed well flow.

[b] Onshore isolation system (OIS) is the landfall valve station where the subsea pipeline ends into the onshore terminal. It will contain onshore process isolation valves that acts as important barriers. The subsea isolation station applies if there are subsea isolation valve(s) along the subsea pipeline routing. The SIS is a subsea manifold structure (e.g. PLEM - Pipeline End Module) with a various type of valves depending on the pipeline infrastructure. The valve design class will typically vary for these valves.

[c] If the valve is a Subsea isolation valve (SSIV), the "Valve component application" needs to be set to SSIV. SSIV is addressed in ISO 14723:2009, see also 3.6.4 in ISO/TR 12489:2013. It is sometimes called SIV. It is a specific type of process isolation valve.

[d] If the subsea pipeline has a T-connection, this will normally contains valves. The valve design class may vary.

[e] The pipeline will normally be subject to pigging, and the associated pig launcher and pig receiver (includes various components) will be located in either end of the pipeline, e.g. subsea, topsides or onshore. The pig station may also be part of the Subunit "Riser base" in the Equipment class "Risers".

[f] Valves have a key barrier function in equipment class "Subsea pipelines" and are maintainable items within a subunit. It is however possible to use equipment class "Valves" (A.2.5.4) if data collection in more depth for dry valves is needed.

Table A.106 — Equipment-specific data — Subsea pipelines

Name	Description	Unit or code list	Priority
Application	Classify	Subsea to onshore Subsea intra-field Offshore facilities to onshore Intercontinental export pipelines Export lines to offloading	High
Type	Classify	Production, injection	
Maximum water depth	Specify	Metres	Medium
Pipeline length	-	Metres	High
Pipeline diameter	Nominal outer diameter (OD)	Millimetre	Medium
Fluid conducted	-	Oil, gas, condensate, oil and gas, gas and condensate, oil/gas/water, CO_2	High

[a] Note that as per ISO/TR 12489:2013, 3.6.4 SSIV can be either an actuated valve (e.g. remotely controlled subsea valve) or non-actuated valve (e.g. subsea check valve). The control system for the subsea pipeline valves will be covered by equipment class "Subsea production control", e.g. static umbilical and subsea control module, plus topsides control equipment (see A.2.6.1).

Table A.106 *(continued)*

Name	Description	Unit or code list	Priority
Pipeline buried	Specify if part or entire pipeline is buried.	Yes/No	High
Number of T-connections	Specify	Number	Medium
Heating system	-	Yes/No	High
Fluid corrosiveness	Classify	Clean Benign Moderate Severe	High
Fluid erosiveness	Classify	Clean Benign Moderate Severe	Medium
Pressure – design	Design pressure	Pascal (bar)	High
Pressure – operating	Operating pressure	Pascal (bar)	Medium
Temperature – design	Design temperature	Degrees Celsius	Medium
Valve application	Pipeline valve function	Pipeline isolation SSIV [a]	High
Valve design class	Type of pipeline valve design	Side-entry ball, top-entry ball, double expanding gate (DEG), slab gate, wedge gate, check	High
Valve actuation	Classify	Hydraulic, Electrical, Manual	High
Valve location	Specify location of pipeline valves	Subsea, topside, landfall/ onshore	High
Valve fail-safe position	Fail-safe-position	Fail-open, Fail-close, Fail-as-is	High

[a] Note that as per ISO/TR 12489:2013, 3.6.4 SSIV can be either an actuated valve (e.g. remotely controlled subsea valve) or non-actuated valve (e.g. subsea check valve). The control system for the subsea pipeline valves will be covered by equipment class "Subsea production control", e.g. static umbilical and subsea control module, plus topsides control equipment (see A.2.6.1).

A.2.6.8 Subsea valve issues

In this International Standard, it is distinguished between the valves used on subsea equipment and the topside valves, such as used on Surface wellheads and X-mas trees. The collection of RM data for the subsea valves should reflect the characteristics of the valves based on the so-called valve design class (i.e. type of valve; corresponds to equipment type in Table A.77) and the valve application (i.e. the function of the valve). Examples of subsea valve applications are given below:

— Flowline isolation: Subsea valves which isolates infield flowline system, e .g. a valve located on a PLEM or a T-connection.

— Manifold isolation: Subsea valve located on a production/injection manifold and which has a barrier function, e.g. a branch valve or a header valve.

— Pipeline isolation: Valves which isolates the pipeline transportation system, and valves could be located subsea or onshore.

— HIPPS: See definition in ISO/TR 12489:2013, 3.6.3.

— SSIV: See definition in ISO/TR 12489:2013, 3.6.4.

A.2.7 Well completion

Valves used on well completion equipment are considered as specific valves within the taxonomy examples shown in this equipment class. Valves used on surface wellhead and X-mas trees are considered as topside valves (see A.2.5.4).

A.2.7.1 Item categories

Well completion equipment in this context refers to equipment below wellhead level. All major completion equipment items are included, from tubing hanger at the top end to equipment at the bottom of the well.

The following subunits are defined for well-completion equipment:

a) Casing

The casing subunit is included to store information on individual casing string maintainable items and associated casing failures. The casing maintainable items represent full lengths of individual casing sections and do not represent individual items threaded into the casing string. Sealing elements that are designed to seal off against leakage of hydrocarbons between the various sections of casing string (casing pack-offs) are not included. Also included in the casing subunit are maintainable items which are set inside the wellbore to isolate the wellbore from potential leakages of well effluents and which cover the entire wellbore. Casing external cement and or other material which is set casing externally to isolate against flow of well effluents/formation fluids is also considered as casing maintainable items.

b) Completion string

Completion string maintainable items are defined as items that are all integral parts of the conduit ("string") used for production or injection of well effluents. The string is built by screwing together a variety of equipment subunits.

c) Insert

The insert subunit consists of maintainable items which can be attached (set) inside the completion string. A typical example is the combination of a lock and wireline-retrievable downhole safety valve set inside a safety valve nipple.

d) Downhole power/control/monitoring

The downhole control/power/monitoring subunit consists of maintainable items which are used to provide power, control or monitoring functions to maintainable item(s) which are categorized under other well completion subunit(s).

A.2.7.2 Equipment specifications