BS EN ISO 13628-15:2011

BSI Standards Publication

Petroleum and natural gas industries — Design and operation of subsea production systems

Part 15: Subsea structures and manifolds (ISO 13628-15:2011)

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EN ISO 13628-15

September 2011

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English Version

Petroleum and natural gas industries - Design and operation of subsea production systems - Part 15: Subsea structures and manifolds (ISO 13628-15:2011)

Industries du pétrole et du gaz naturel - Conception et exploitation des systèmes de production immergés - Partie 15: Structures immergées et manifolds (ISO 13628-15:2011)

Erdöl- und Erdgasindustrie - Auslegung und Betrieb von Unterwasser-Produktionssystemen - Teil 15: Unterwasser-Aufbauten und Verteilerstücke (ISO 13628-15:2011)

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Foreword

This document (EN ISO 13628-15:2011) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2012, and conflicting national standards shall be withdrawn at the latest by March 2012.

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Foreword

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ISO 13628-15 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

ISO 13628 consists of the following parts, under the general title *Petroleum and natural gas industries — Design and operation of subsea production systems*:

— *Part 1: General requirements and recommendations*

— *Part 2: Unbonded flexible pipe systems for subsea and marine applications*

— *Part 3: Through flowline (TFL) systems*

— *Part 4: Subsea wellhead and tree equipment*

— *Part 5: Subsea umbilicals*

— *Part 6: Subsea production control systems*

— *Part 7: Completion/workover riser systems*

— *Part 8: Remotely operated tools and interfaces on subsea production systems*

— *Part 9: Remotely Operated Tool (ROT) intervention systems*

— *Part 10: Specification for bonded flexible pipe*

— *Part 11: Flexible pipe systems for subsea and marine applications*

— *Part 15: Subsea structures and manifolds*

A Part 12, dealing with dynamic production risers, a Part 14, dealing with high-integrity pressure protection systems (HIPPS), a Part 16, dealing with specification for flexible pipe ancillary equipment, and a Part 17, dealing with recommended practice for flexible pipe ancillary equipment, are under preparation.

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INTERNATIONAL STANDARD ISO 13628-15:2011(E)

Petroleum and natural gas industries — Design and operation of subsea production systems —

Part 15: Subsea structures and manifolds

1 Scope

This part of ISO 13628 addresses recommendations for subsea structures and manifolds, within the frameworks set forth by recognized and accepted industry specifications and standards. As such, it does not supersede or eliminate any requirement imposed by any other industry specification.

This part of ISO 13628 covers subsea manifolds and templates utilized for pressure control in both subsea production of oil and gas, and subsea injection services. See Figure 1 for an example of such a subsea system.

Equipment within the scope of this part of ISO 13628 is listed below:

a) the following structural components and piping systems of subsea production systems:

- production and injection manifolds,
- modular and integrated single satellite and multiwell templates,
- subsea processing and subsea boosting stations,
- flowline riser bases and export riser bases (FRB, ERB),
- pipeline end manifolds (PLEM),
- pipeline end terminations (PLET),
- T- and Y-connection,
- subsea isolation valve (SSIV);

b) the following structural components of subsea production system:

- subsea controls and distribution structures,
- other subsea structures;

c) protection structures associated with the above.

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The following components and their applications are outside the scope of this part of ISO 13628:

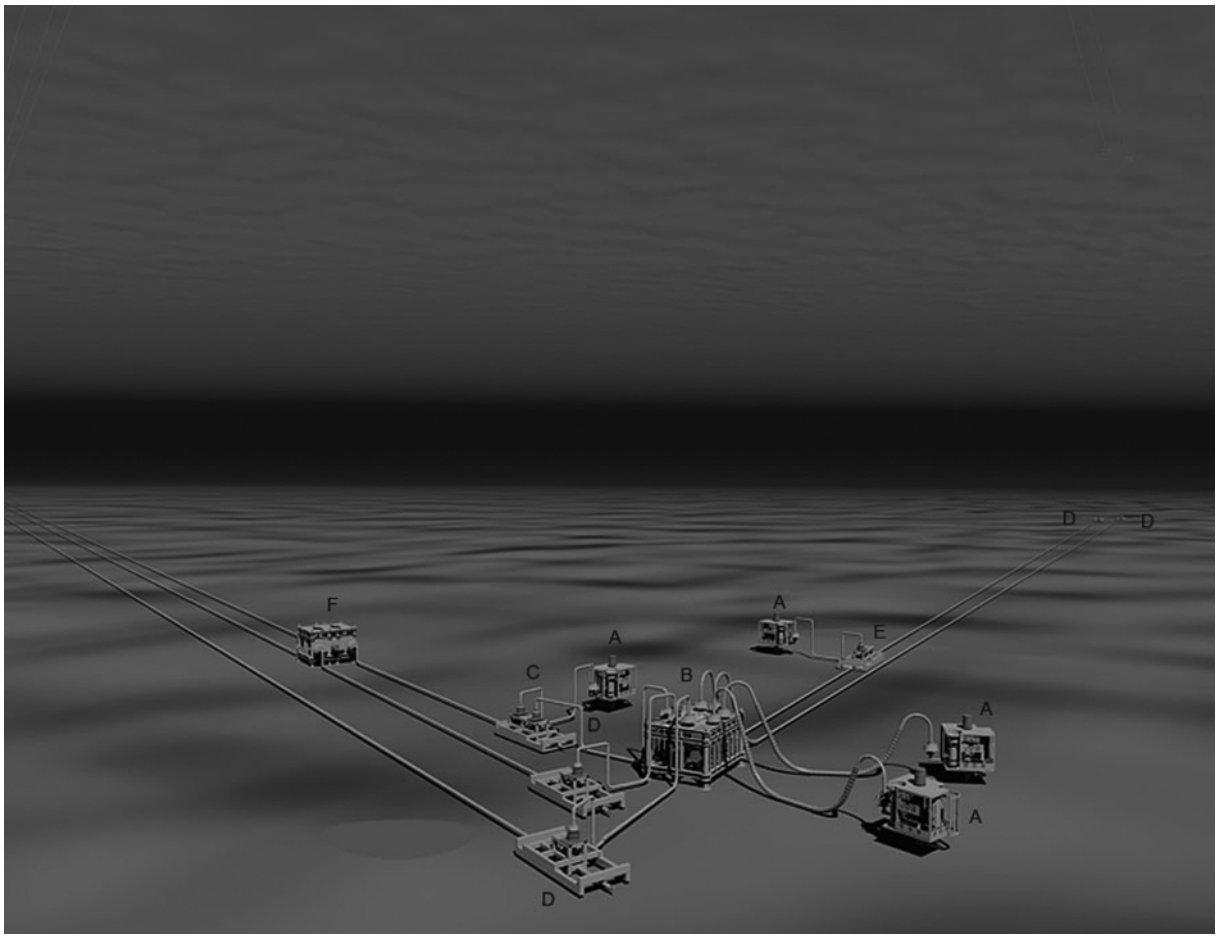
— pipeline and manifold valves;

— flowline and tie-in connectors;

— choke valves;

— production control systems.

NOTE General information regarding these topics can be found in additional publications, such as ISO 13628-1 and API Spec 2C.



Key

A tree

B cluster manifold

C PLEM

D PLET

E inline tee

F multi-phase pump skid

Figure 1 — Example of some typical subsea structures

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2 Normative references

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

ISO 3183, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 9606 (all parts), *Qualification test of welders — Fusion welding*

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

ISO 10423, *Petroleum and natural gas industries — Drilling and production equipment — Wellhead and christmas tree equipment*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 13628-1:2005, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 1: General requirements and recommendations*

ISO 13628-1:2005/Amd 1:2010, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 1: General requirements and recommendations — Amendment 1: Revised Clause 6*

ISO 13628-4, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 4: Subsea wellhead and tree equipment*

ISO 13628-8, *Petroleum and natural gas industries — Design and operation of subsea production systems — Part 8: Remotely operated tools and interfaces on subsea production systems*

ISO 14731:2006, *Welding coordination — Tasks and responsibilities*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in H_2S-containing environments in oil and gas production*

ISO 15590-1, *Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 1: Induction bends*

ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure specification*

ISO 15614 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure test*

EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

EN 10228-3, *Non-destructive testing of steel forgings — Part 3: Ultrasonic testing of ferritic or martensitic steel forgings*

ASME B31.3, *Process Piping*

ASME V, 2007, Boiler and Pressure Vessel Code (BPVC), Section V, *Nondestructive Examination*

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ASME VIII, 2007, Boiler and Pressure Vessel Code (BPVC), Section VIII, *Rules for Construction of Pressure Vessels*, Div. 1

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

ASNT SNT-TC-1A, *Recommended Practice No. SNT-TC-1A, Personnel qualification and certification in nondestructive testing*

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

ASTM E562, *Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count*

ASTM G48, *Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution*

NS 477, *Welding — Rules for qualification of welding inspectors*

3 Terms, abbreviated terms, and definitions

For the purposes of this document, the following terms, abbreviated terms and definitions apply.

3.1 Terms and definitions

3.1.1
carbon steel
full range of carbon, carbon-manganese and low-alloy steels used in the construction of conventional oilfield equipment

3.1.2
corrosion-resistant alloy
CRA
alloy that is intended to be resistant to general and localized corrosion in oilfield environments that are corrosive to carbon steels

NOTE This definition is in accordance with ISO 15156 (all parts) and is intended to include materials such as stainless steels and nickel base alloys. Other ISO documents can have other definitions.

3.1.3
driven pile
jetted pile
typically a tall steel cylindrical structure, with or without internal stiffener system, used to support subsea structures

NOTE Driven piles are usually driven into the sea-floor with impact hammers, while jetted piles rely on jetting the soil at the lower end of the pile.

3.1.4
inline tee
system of piping and valves used to make a subsea connection at the middle of a pipeline, and generally integral to the pipeline

NOTE The pipeline may be used to transport produced fluids or to distribute injected fluids.

3.1.5
low-alloy steel
steel containing at least 1 % and less than 5 % of elements deliberately added for the purpose of modifying properties

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3.1.6
manifold
system of headers, branched piping and valves used to gather produced fluids or to distribute injected fluids in subsea oil and gas production systems

NOTE A manifold system can also provide for well testing and well servicing. The associated equipment can include valves, connectors for pipeline and tree interfaces, chokes for flow control and TFL diverters. The manifold system can also include control system equipment, such as a distribution system for hydraulic and electrical functions, as well as providing interface connections to control modules. All or part of the manifold can be integral with the template or can be installed separately at a later date if desired. Manifold headers can include lines for water or chemical injection, gas lift and well control.

3.1.6.1
cluster manifold
structure used to support a manifold for produced or injected fluids

NOTE There are no wells on a cluster manifold.

3.1.7
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

3.1.8
pipeline end manifold
PLEM
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

3.1.9
pipeline end termination
PLET
system of piping and valves, generally integral to the pipeline, used to make a subsea connection at the end of a pipeline

NOTE 1 Typically, a PLET has only one subsea connection.

NOTE 2 The pipeline can be used to transport produced fluids or to distribute injected fluids.

3.1.10
pitting resistance equivalent number
PREN
index that exists in several variations and usually based on observed resistance to pitting of corrosion-resistant alloys in the presence of chlorides and oxygen, e.g. as found in seawater

NOTE Though useful, these indices are not directly indicative of the resistance to produced oil and gas environments. The most common examples are given in Equations (1) and (2):

$$f_{\mathrm{PREN}} = w_{\mathrm{Cr}} + 3{,}3w_{\mathrm{Mo}} + 16w_{\mathrm{N}} \quad (1)$$

$$f_{\mathrm{PREN}} = w_{\mathrm{Cr}} + 3{,}3(w_{\mathrm{Mo}} + 0{,}5w_{\mathrm{W}}) + 16w_{\mathrm{N}} \quad (2)$$

where

w_{Cr} is the mass fraction of chromium in the alloy, expressed as a percentage of the total composition;

w_{Mo} is the mass fraction of molybdenum in the alloy, expressed as a percentage of the total composition;

w_{W} is the mass fraction of tungsten in the alloy, expressed as a percentage of the total composition;

w_{N} is the mass fraction of nitrogen in the alloy, expressed as a percentage of the total composition.

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3.1.11
protection structure
independent structure that protects subsea equipment against damage from dropped objects, fishing gear and other relevant accidental loads

3.1.12
riser base
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

NOTE A riser base can also include a pipeline connection capability.

3.1.13
sealine
subsea flowline

3.1.14
sour service
service in H_2S-containing fluids

NOTE In this part of ISO 13628, “sour service” refers to conditions where the H_2S content is such that restrictions as specified in ISO 15156 (all parts) or NACE MR 0175 apply.

3.1.15
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

NOTE A suction pile is installed by first lowering it into the soil to self-penetration depth (i.e. penetration due to submerged pile weight). The remainder of the required penetration is achieved by pumping out the water trapped inside the suction pile.

3.1.16
sweet service
service in H_2S-free fluids

3.1.17
template
seabed structure that provides guidance and support for drilling and includes production/injection piping

NOTE 1 A template typically comprises a structure that provides a guide for drilling and/or support for other equipment, and provisions for establishing a foundation (piled or gravity-based), and is typically used to group several subsea wells (modular manifold) at a single seabed location.

NOTE 2 Production from the templates can flow to floating production systems, platforms, shore or other remote facilities.

NOTE 3 Templates can be of a unitized or modular design.

3.1.17.1
modular template
template installed as one unit or as modules assembled around a base structure (often the first well)

NOTE If installed as one unit, the template is of a cantilevered design. If installed as modules, these modules can be of cantilevered design.

3.1.17.2
drilling template
multi-well template used as a drilling guide to predrill wells prior to installing a surface facility

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NOTE The wells are typically tied back to the surface facility during completion. The wells can also be completed subsea, with individual risers back to the surface.

3.1.18
type 316
austenitic stainless steel alloy

EXAMPLES UNS S31600/S31603.

3.1.19
type 6Mo
austenitic stainless steel alloy having PREN ≥ 40 mass fraction and Mo alloying ≥ 6,0 % mass fraction, and nickel alloy having a Mo content in the range 6 % mass fraction to 8 % mass fraction

3.1.20
type 22Cr duplex
ferritic/austenitic stainless steel alloy with 30 < PREN ≤ 40 and Mo > 1,5 % mass fraction

EXAMPLES UNS S31803 and S32205 steels.

3.1.21
type 25Cr duplex
ferritic/austenitic stainless steel alloys with 40 ≤ PREN < 45

EXAMPLES S32750 and UNS S32760 steels.

3.1.22
verification
confirmation that specified design requirements have been fulfilled, through the provision of objective evidence

NOTE Typically verification is achieved by calculations, design reviews, and hydrostatic testing.

3.1.23
validation
confirmation that the operational requirements for a specific use or application have been fulfilled, through the provision of objective evidence

NOTE Typically validation is achieved by qualification testing and/or system integration testing.

3.2 Abbreviated terms

ACCP ASNT Central Certification Program

API American Petroleum Institute

ASME American Society of Mechanical Engineers

ASTM American Society for Testing and Materials

ASNT American Society of Nondestructive Testing

AWS American Welding Society

BOP blowout preventer

BPVC Boiler and Pressure Vessel Code

CE_{IIW} carbon equivalent, based on the International Institute of Welding equation

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CE_{Pcm}	carbon equivalent, based on the chemical portion of the Ito-Bessyo carbon equivalent equation
CRA	corrosion-resistant alloy
DAC	distance amplitude curve
DNV	Det Norske Veritas
EWF	European Federation for Welding, Joining and Cutting
EN	European Norm
FBH	flat-bottom hole
FIV	flow-induced vibration
FL	fusion line
GMAW	gas metal arc welding
GTAW	gas tungsten arc welding
HAZ	heat-affected zone
HAZOP	hazard and operability analysis
H_D	diffusible hydrogen, expressed as ml/100 g deposited metal
HIP	hot isostatic pressed
IDS	interface data sheet
IIW	International Institute of Welding
IWE	International Welding Engineer
LP	liquid penetrant
MAG	metal-active gas
MDT	minimum design temperature
MEG	monoethylene glycol
MIG	metal-inert gas
NDT	non-destructive testing
NORSOK	Norsk Sokkels
NS	Standards Norway
O-ROV	observation/inspection-class remote operated vehicle
P&ID	process and instrumentation diagram
PLEM	pipeline end manifold

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PLET	pipeline end termination
PQR	procedure qualification record
PREN	pitting resistance equivalent number
PSL	product specification level
PWHT	post-weld heat treatment
ROT	remotely operated tool
ROV	remotely operated vehicle
SAFOP	safety and operability analysis
SCM	subsea control module
SMYS	specified minimum yield strength
SSIV	subsea isolation valve structures
TFL	through-flow loop
UNS	Unified Numbering System
UT	ultrasonic testing
VIV	vortex induced vibration
WM	weld metal
WPS	welding procedure specification
WPQR	weld procedure qualification record
W-ROV	work-class remotely operated vehicle
XT	christmas tree

4 Manifold and template functional considerations

4.1 General

4.1.1 Manifold system design typically fulfils the following functions:

a) gather production or distribute water or gas from or to multiple production, water, or gas injection wells;

b) direct flow of fluids through manifold headers;

c) contain one or more headers;

d) allow isolation of individual well slots from header;

e) incorporate flowline connections between manifolds and appropriate flowlines and/or test lines;

f) allow continuity of pigging of flowline system.

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4.1.2 The end user should define or approve the following performance and configuration requirements, including

— maximum dimensions and target weight;

— pressure and temperature ratings;

— equipment interfaces;

— process and instrumentation diagrams (P&IDs);

— materials requirements;

— water depth;

— design life;

— geotechnical and geophysical data;

— metocean data;

— dropped-objects protection requirements;

— over-trawling requirements including special fishing gear loads (snag loads) for the geographic region.

4.1.3 All equipment should

— comply with the latest revision of end user's product requirements;

— be designed to the pressure and temperature ratings;

— be compatible (dimensions and mass) with handling and installation capabilities of the installation vessel;

— be functional and fit for purpose for specified operating environment.

Subsea production or injection manifolds should be located in proximity to production or injection wells of field development.

4.1.4 Material selection for individual components, including all seal materials, should meet the requirements of ISO 13628-1 concerning

— production, injection fluids, and completion fluids for wetted areas;

— exposure to chemical injection and service fluids. This applies equally to seal materials.

NOTE For the purposes of this provision, ANSI/API RP 17A is equivalent to ISO 13628-1.

Manifolds typically provide termination points for flowlines.

Subsea tree tie-ins may be directed to flow product into or out of a flowline system by remotely or manually functioning valves on a manifold.

4.2 System requirements

The flexibility to meet various production scenarios (e.g. “retrofit” installation of pumps, separators and other modules) and possible future expansions should be considered. For each design, potential future requirements should be addressed, and it should be clearly explained how the manifold system is prepared for implementing the identified functions.

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The following considerations related to structures and modules should be addressed:

— transportation, lifting, installation (inclusive of potential levelling), abandonment;

— flowline pull-in, connection and testing;

— well drilling, completion, workover and XT installation;

— precommissioning and commissioning;

— production/injection start-up and production/injection;

— injection of chemicals, such as emulsion, scale, wax and corrosion inhibitors;

— methanol or MEG injection for hydrate control;

— thermal performance;

— annulus bleed operations;

— well testing;

— barrier testing;

— planned and emergency shutdowns of wells and manifold;

— pressurization and depressurization of piping system;

— pigging of flowlines, such as for gauge and cleaning operations;

— ROV/ROT inspections and interventions, inclusive of module replacement;

— sand/pig detection facilities inspection;

— well interventions;

— potential hook-up of retrofit-installed modules and components;

— seawater ingress during tie-in operations;

— corrosion protection;

— erosion protection;

— wall thickness measurement;

— fluid flow rate;

— pressure drop through piping system;

— fluid composition;

— fluid flow regimes (slugging).

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4.3 System Interfaces

4.3.1 The system interfaces should maintain integrity and functionality in the service conditions and take into account the following:

— internal and external pressure;

— simultaneous expansion and contraction on the same structure, whether the structure is an XT, a module, a template or a manifold;

— zero external leakage and seawater ingress;

— tolerance loops for interface make-up;

— internal and external temperature variations;

— structure for protection against dropped objects and fishing gear;

— impact from dropped objects and fishing gear;

— short- and long-term structure settlement;

— marine growth;

— corrosion and erosion;

— scaling on subsea mate-able surfaces;

— potential formation of hydrate;

— installation loads;

— pull-in and connection loads;

— projected product lifespan;

— serviceability;

— protection from ROV impact loads;

— subsea controls connection systems;

— chemical injection requirements.

4.3.2 Interface data sheets and outlined installation procedures for critical external interface areas should be provided. The data sheets, when implemented, should clearly describe design limitations, weights and dimensions as applicable. Areas that, as a minimum, should be covered are

— interfaces towards the well system, including maximum conductor angle, hang-off weights, lengths of conductor, BOP envelopes, sequential requirements (sequence and number of wells that can be drilled before design load capacity is achieved), limitation on mud pressure/flow during drilling out the conductor, cement/grouting strength, well growth, wellhead design, etc.;

— interfaces towards marine contractor (equipment mass and size, lifting height, deck space, load capacity of tie-in points and structures, installation limitations, sea states, etc.);

— interfaces towards flowline jumpers and well jumpers, controls flying leads.

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4.4 Cluster manifold requirements

4.4.1 General

The cluster manifold consists of a framework that supports other equipment, such as piping, pipeline pull-in and connection equipment, and protective framing. The cluster manifold commingles flow from a number of subsea wells into one or more headers. The cluster manifold provides a foundation to sufficiently transfer design loads into the seabed. The cluster manifold may include the following components; see Figure 2:

— subsea control module;

— subsea distribution unit;

— electrical distribution unit.

4.4.2 Alignment

The cluster manifold should provide alignment capability for proper physical interfaces with other subsystems, such as connectors and foundations.

4.4.3 Guidance system

The cluster manifold should provide for a guidance system to support operations through the life of the installation. If guidelines are used, the cluster manifold should provide proper spacing and installation/maintenance capability for the guide posts. If guideline-less methods are used, the cluster manifold should provide sufficient space and passive guidance capability to successfully install key equipment items.

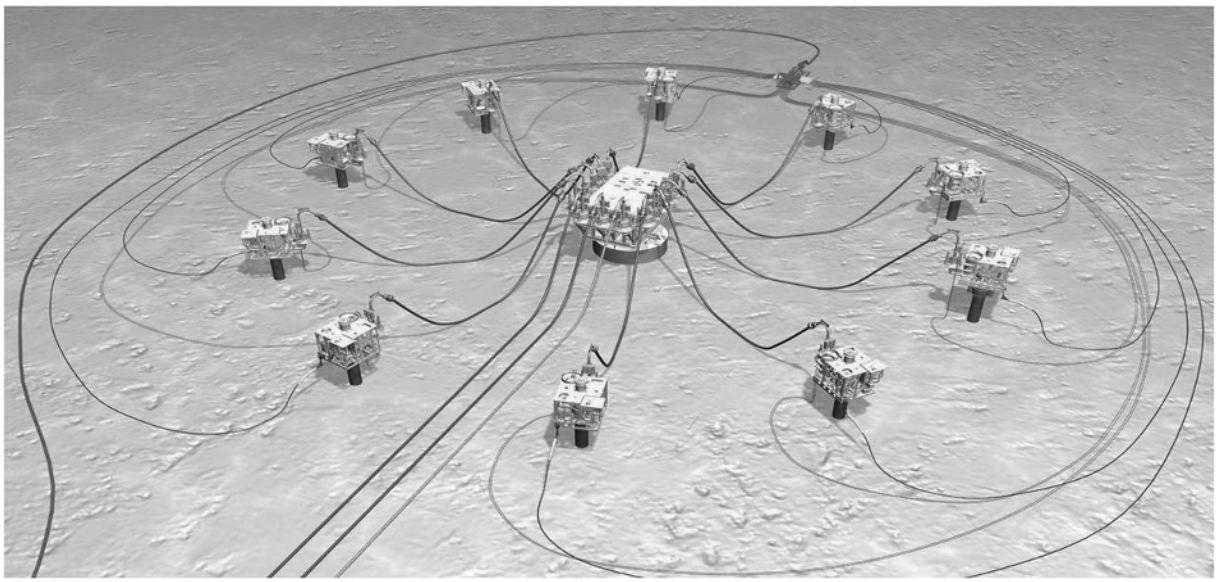

Figure 2 — Typical cluster manifold

4.5 Template system requirements

4.5.1 General

The framework of a template supports equipment such as manifolds, risers, drilling and completion equipment, pipeline pull-in and connection equipment and protective framing (template and protective framing are often built as one integrated structure). The template should provide a foundation to sufficiently transfer design loads into the seabed. See Figure 3.

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4.5.2 Drilling and completion interface

If wells will be drilled through the template, it should provide a guide for drilling, landing/latching capability for the first casing string, and sufficient space for running and landing a BOP stack. If subsea trees will be installed, the template should provide proper mechanical positioning and alignment for the trees and sufficient clearance for running operations.

4.5.3 Alignment

The template should provide alignment capability for proper physical interfaces among subsystems, such as wellhead/tree, tree/manifold and manifold/flowlines.

4.5.4 Guidance system

The template should provide for a guidance system to support operations through the life of the installation. If guidelines are used, the template should provide proper spacing and installation/maintenance capability for the guide posts. If guideline-less methods are used, the template should provide sufficient space and passive guidance capability to successfully install key equipment items.

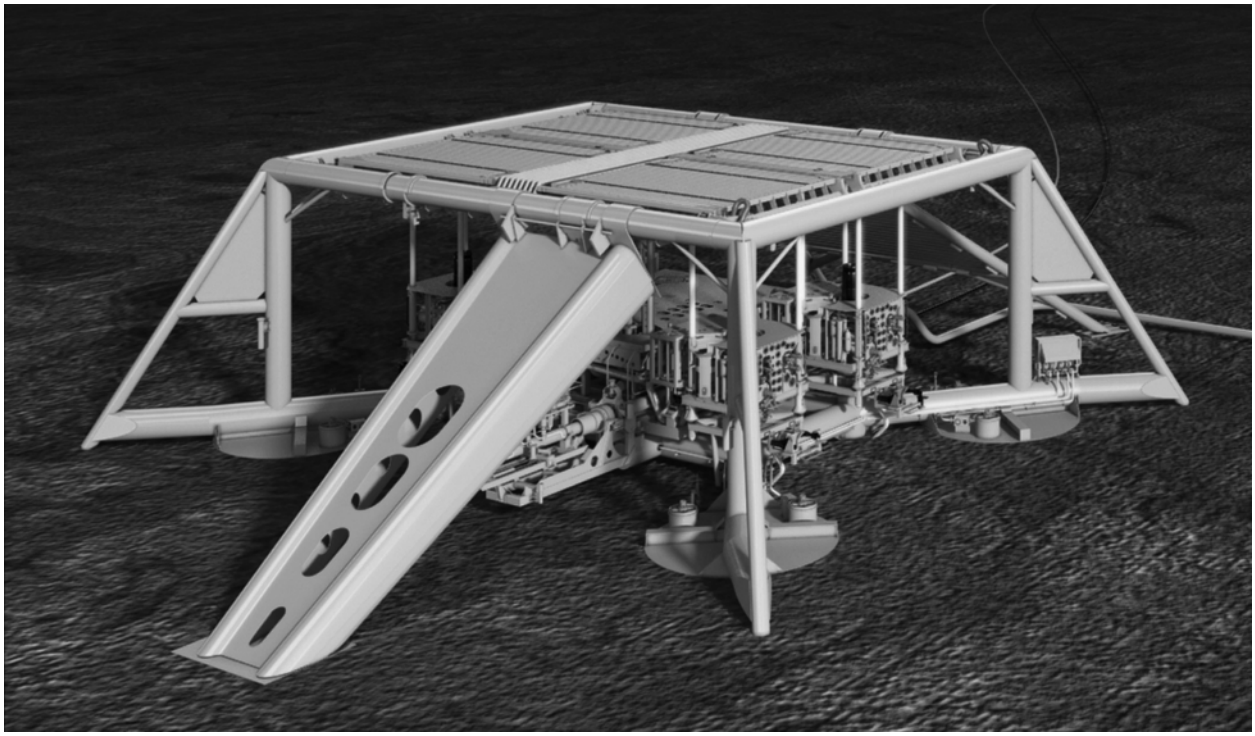

Figure 3 — Typical template system

5 Design considerations

5.1 System design

5.1.1 Number of wells

If wells are incorporated into the template or cluster manifold, the number of wells will vary depending on the site-specific application, and will greatly influence template size and manifold design. The addition of spare well slots should be considered for contingencies such as changes in reservoir depletion plan, dry holes, drilling problems and other unforeseen production requirements.

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5.1.2 Well spacing

Well spacing may be governed by the type and size of drilling and production equipment used, the functional requirements of the manifold, and subsequent maintenance and inspection requirements. Consideration should be given to providing space for such items as flowline and wellhead connections and their running tools, and adjacent BOP and production tree clearances. Access should also be provided for inspection and maintenance tools.

5.1.3 Maintenance

Maintenance is a key factor in system design, and the maintenance approach should be considered early in the design of a template/manifold system.

Some factors to consider are

— diver-assisted or remote maintenance methods;

— the requirement that components be retrievable;

— clear access space for divers, ROVs or other maintenance equipment;

— clear markings to allow distinguishing similar components;

— height above seabed for adequate visibility;

— system safety with components removed;

— fault detection to identify failed components.

5.1.4 Barrier philosophy

See ISO 13628-1:2005, Annex J for additional information on barrier philosophy.

Permanent isolation requirements against external leakage for pressurized systems should be provided by double, pressure-containing barriers in all applicable external connection points, and in particular

a) un-utilized end connections or prior to hook-up of XT in combination with pressurized manifold piping:

   two pressure barriers are required, one isolation valve and one pressure plug or cap or two isolation valves;

b) prior to hook-up of XT in combination with non-pressurized manifold piping:

   one pressure barrier, in combination with a protection device that retains inhibited fluids to protect the environmental side of the isolation valve in order to avoid seawater-imposed corrosion of and fouling on the valve, is required; the pressure barrier can be provided by the manifold branch valve, while the protection device can be provided by a pressure cap on the hub towards the XT;

c) for diver-mated connections:

   It is recommended to have two pressure barriers with a block-and-bleed function.

For temporary, time-limited operations, it can be acceptable to use only one valve for isolating a manifold pressurized towards the environment. The valve should be checked to ensure it is holding pressure prior to releasing the outboard barrier, in combination with an overall safety assessment for the activity.

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