

DEP SPECIFICATION

SINGLE POINT MOORING (SPM) SYSTEMS

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design, manufacture, construction, and installation of catenary anchor leg mooring (CALM) single point mooring (SPM) systems.

The SPM system consists of the Mooring Buoy, mooring system, mooring assemblies, floating and submarine hoses and Pipeline end manifold (PLEM).

The two types of mooring buoys are the turntable type and the turret type. The type selected is based on the site and operating conditions. The requirements/recommendations in this DEP apply to both types, unless otherwise specified.

For specific components of the system, relevant DEPs or external standards are referenced. The battery limit for the product transfer system is the pipeline-to-PLEM connection. The PLEM requirements are included in this DEP; the offshore pipeline is addressed in other DEPs.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2015; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use for CALM type SPM systems in shallow water, less than 50 m (164 ft) deep. Systems for deeper waters will be designed for their own particular functional requirements, to be established on a project basis. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, installation, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Abbreviations

Term	Definition
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CALM	Catenary Anchor Leg Mooring
CNAF	Compressed Non-Asbestos Fibre
COG	Centre Of Gravity
DFT	Dry Film Thickness
ESD	Emergency Shut-Down
FF	Flat or Full Face
FFWN	Flat Face Weldneck
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HEMP	Hazard Effect Management Process
HPU	Hydraulic Power Unit
HSSE	Health, Safety, Security, and Environment
ISO	International Organization for Standardization
ITP	Inspection and Test Plan

Term	Definition
LED	Light Emitting Diode
LTM	Long Term Mooring
MBC	Marine Breakaway Coupling
MESC	Materials and Equipment Standards and Code
MMA	Mooring and Manoeuvring Area
NDE	Non Destructive Examination
NPT	National Pipe Thread
OSR	Oil Spill Response
PEFS	Process Engineering Flow Schemes
PFS	Process Flow Scheme
PLEM	Pipeline End Manifold
QA/QC	Quality Assurance / Quality Control
RF	Raised Face
RFWN	Raised Face Weldneck
SBM	Single Buoy Mooring (in this document referred to as SPM)
SPIR	Spare Parts Interchangeability Record
SPM	Single Point Mooring (in this document of the CALM type)
SWL	Safe Working Load
TAMAP	Technically Accepted Manufacturers and Products
UXO	Unexploded Ordnance

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (14).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2015.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall / should / may for normative statements.
3.11 Item 4	Reworded and renumbered to 3.11 item 3
4.1 Item 2	Renumbered to 4.1 item 1
5.2.1 Item 3	Separated the shall/should statements nested within SHALL[PS] and renumbered.
5.2.7.2 Item 3	Separated the shall/should statements nested within SHALL[PS] and renumbered.
5.3.1 Item 7	Renumbered.
5.4.1 Item 3	Reworded to bring clarity that Cofferdam arrangement is also a requirement

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. CONCEPT AND PHILOSOPHIES

2.1 GENERAL

This section specifies key functional requirements for the development of the SPM system concept, essential for design, manufacture, construction, operation and maintenance.

1. In order to layout and document the SPM system concept the following shall be established and documented by the Contractor in consultation with the Principal prior to further implementation of the project:
 - a. HSSE philosophy (2.2);
 - b. operation and maintenance philosophy, inclusive of venting, draining and pigging operations if applicable (2.3);
 - c. quality philosophy (2.4);
 - d. design philosophy (2.5);
 - e. third party interaction (2.6);
 - f. availability analysis (2.8);
 - g. emergency shutdown philosophy (2.3);
 - h. control and monitoring philosophy (2.7);
 - i. spare parts philosophy (2.9).

2.2 HSSE PHILOSOPHY

1. An overall HSSE philosophy shall be established and implemented through all phases of the project from its initiation through to operation, in consultation with the Principal with particular focus on the following elements:
 - a. activities in the area of the SPM system, including the users of the system, support activities, or third party activities;
 - b. impact on the environment from installation through operation to de-commissioning of the SPM system.
2. A systematic review comprising of HAZID, HAZOP, HEMP, and Risk Assessment shall be performed during each phase of the project including operational phase whenever there is a change to confirm the suitability of the SPM system.
3. The risk assessment shall show all risks to be as low as reasonably practicable (ALARP).
4. The risk assessment should cover, as a minimum, the failure of the following main functional systems:
 - a. product transfer system;
 - b. mooring load transfer system;
 - c. buoyancy system;
 - d. rotation system;
 - e. safety system;
 - f. navigation aids, electrical and control system;
 - g. maintenance support system.

2.3 OPERATIONS AND MAINTENANCE PHILOSOPHY

2.3.1 General

1. The operational and maintenance philosophy shall:
 - a. convey information for design, engineering and manufacturing of the planned SPM system;
 - b. provide the basis for the SPM buoy operation and maintenance manual;
 - c. provide the basis for the SPM terminal marine operation manual.
2. In the concept development phase, an operation and maintenance philosophy shall be established that forms the basis of the following:
 - a. SPM terminal availability requirement;
 - b. SPM system availability requirement considering the system component availability;
 - c. maintenance and component replacement intervals;
 - d. sparing philosophy;
 - e. system overhaul frequency;
 - f. inspection, maintenance, tools and vessels;
 - g. marine operations considering the operational window for mooring and de-berthing manoeuvring, piloting, requirements for tug support, etc.;
 - h. pump, pipeline, product characteristics and flow direction;
 - i. definition of operating and maintenance facilities such as storage for spares, maintenance workshop, hose string make-up site, control room;
 - j. requirement for shore based support facilities, such as waterfront access, hose ramp, equipment storage and cover, mooring facility for work boats, workshop;
 - k. design temperature and pressure, operating temperature and pressure and surge, flowrate, capacity and volumes;
 - l. flow control for start-up, normal operation, normal shutdown and emergency shutdown (ESD);
 - m. valve operation, means, frequency, location, i.e., local or remote for SPM and pipeline end manifold (PLEM), manual or actuated;
 - n. number of products;
 - o. pigging requirements and operations;
 - p. flushing;
 - q. diving operations;
 - r. system interfaces;
 - s. firefighting requirements;
 - t. oil spill containment/pollution mitigation requirements.

2.3.2 Product transfer philosophy

1. For the transfer of different products through a single SPM system, a design philosophy taking into consideration product parameters (3.7.2) shall be developed for the transfer method.

2.3.3 Flushing philosophy

1. The flushing philosophy for the terminal product transfer system shall be established to provide the basis for the lay-out of the SPM system, including the following:
 - a. flushing fluid to be used;
 - b. flushing direction;
 - c. flushing process monitoring;
 - d. flushing facilities such as valves (including non-return valves), tie-in points, by-passes, etc.

2.3.4 Pigging philosophy

1. A pigging philosophy shall be established addressing the operational and non-routine pigging operations.
2. Refer following DEPs for pigging requirements relevant for the PLEM configuration.
 - a. Pre-commissioning of pipelines: DEP 31.40.50.30-Gen.
 - b. Pipeline engineering: DEP 31.40.00.10-Gen., DEP 31.40.10.13-Gen.
 - c. Piping – general requirements: DEP 31.38.01.11-Gen.

2.3.5 Process flow scheme

1. A functional lay-out of the product transfer system concept shall be made.
2. The Contractor shall consider the various piping options available and present to the Principal for approval a clear rationale for the selected lay-out based on the operating and maintenance, control and monitoring and pigging philosophies.
3. The process flow scheme (PFS) shall indicate the components and the line sizes of the complete product transfer system and reflect related philosophies and the intended operating method. The PFS should show the following:
 - a. buoy piping lay-out;
 - b. swivel lay-out;
 - c. PLEM piping lay-out;
 - d. PLEM pigging arrangement;
 - e. submarine hose arrangement;
 - f. floating hose arrangement;
 - g. spool pieces with piping to hose diameter transitions;
 - h. redundancy in product transfer system, submarine hoses, swivel paths, floating hoses;
 - i. operational valves;
 - j. valve type and operator;
 - k. maintenance isolation valves;
 - l. ESD valve arrangement;
 - m. crossovers and bypasses;
 - n. system safeguards such as surge relief and Marine Breakaway Couplings (MBCs);
 - o. battery limits.

2.3.6 Marine operations philosophy

1. Marine operations parties should be involved at the concept development stage in the SPM terminal development and SPM buoy specification.
2. Marine operations philosophy shall establish the following:
 - a. SPM terminal maintenance support vessel fleet operation (need for, and extent of, the deployment of supporting vessels);
 - b. tanker mooring and cargo transfer support operations, including the following:
 - i. requirement of tug support during approach and manoeuvring;
 - ii. definition of approach and departure routes;
 - iii. requirement of navigation buoys;
 - iv. definition of anchorage area;
 - v. definition of exclusion zone;
 - vi. pilotage requirements and philosophy;
 - vii. cargo transfer operation philosophy;
 - viii. communication between SPM system and tanker;
 - ix. emergency and OSR philosophy;
 - x. local authority marine requirement.

2.4 QUALITY PHILOSOPHY

1. Throughout the project a quality assurance system shall be implemented in accordance with ISO 9001.

2.5 DESIGN PHILOSOPHY

1. A consistent framework of design codes shall be mandated at the initiation of the project.

This DEP complements the requirements of such design codes by defining specific requirements.
2. The codes should address all relevant design conditions and define engineering and design standards for all components of the system.

2.6 THIRD PARTY INTERACTION

1. Risks associated with the third party activities in the area shall be managed in the design operations and the mitigating measures identified in the risk assessment be implemented.

2.7 CONTROL AND MONITORING PHILOSOPHY

2.7.1 General

1. The control and monitoring philosophy shall be developed in conjunction with the operation and maintenance philosophy (2.3).
2. The conceptual layout of instrumentation and control block diagram presenting the control and monitoring philosophy shall be produced for review.
3. The control and monitoring philosophy shall establish:
 - a. data to be measured and recorded, without real time transfer to the control system (no signals, possible local recorder);
 - b. data to be measured and transferred in real time to the control system (passive signals);
 - c. data to be transferred from the control system to the system and method of interface (active signals);
 - d. operation and read-out locations.

2.7.2 Data communication philosophy

1. If the control and monitoring philosophy requires remote readout and/or operation, a data communication philosophy shall be addressed.
2. For telemetry systems, tanker shadowing between the transmitter and receiver station shall be considered.

2.7.3 Power philosophy

1. A power philosophy shall be established considering the emergency shutdown philosophy, control and monitoring philosophy, data communication philosophy and a preliminary equipment load balance.
2. For systems with low power demand such as the navigation light only, battery replacement should be considered.

2.8 AVAILABILITY ANALYSIS

1. An availability study shall be performed to determine the berth occupancy of the SPM terminal.

2.9 SPARE PARTS PHILOSOPHY

1. A spare parts philosophy shall be developed considering the operations and maintenance philosophy in accordance with DEP 70.10.90.11-Gen.

3. DESIGN DATA

3.1 GENERAL

1. Design data specified in this DEP section shall be determined and provided by the Principal to the Manufacturer of the SPM system.

3.2 SYSTEM DESIGN LIFE

1. The Principal will define the system design life.

3.3 BATTERY LIMITS AND SPM SYSTEM INTERFACES

1. The battery limits for the SPM system shall be clearly defined considering the whole SPM terminal and project development risks demonstrated to be ALARP (e.g., minimizing interface complexity and mitigating project development risks identified).

3.4 CLASSIFICATION/CERTIFICATION

1. The requirements for classification or certification of the system shall be specified.

3.5 ENVIRONMENTAL DESIGN CONDITIONS

1. The meteorological and oceanographic conditions, for the design, installation and offshore operations, shall be described as per DEP 37.00.10.11-Gen.

3.6 SITE CONDITIONS

1. The site conditions shall be determined for the selection of the SPM system lay-out, confirmation of nautical safety, and the design of the pipeline and shore approach, PLEM, mooring system and anchor points.
2. Site survey requirements shall be defined in a survey scope of work and specification that will form the basis for the field work activities.
3. The survey scope of work should specify as a minimum, requirements for the following:
 - a. Health, safety, security and environment (HSSE);
 - b. Quality control;
 - c. Survey procedures;
 - d. Scope of survey activities;
 - e. Data coverage;
 - f. Horizontal and vertical datum;
 - g. Positioning accuracy;
 - h. Data quality and accuracy;
 - i. Vessel, equipment, and personnel;
 - j. Data analysis;
 - k. Interpretation, reporting and documentation.
4. The site surveys should comprise a geophysical survey, a geotechnical survey and bathymetry of the ship manoeuvring area and SPM buoy surroundings, PLEM and pipeline.
5. A shallow water shore approach survey shall ensure there is sufficient data overlap for integration between the onshore and offshore surveys.
6. The offshore survey shall:
 - a. determine water depth in the approaches, in the Mooring and Manoeuvring Area (MMA), and at the SPM location;
 - b. determine seabed features relevant for design and operations, such as outcrops, reefs, or obstacles;
 - c. determine soil conditions and establish engineering properties and characteristics of the soils for PLEM foundation design, anchor point design, pipeline stability, and trenching.

7. The geophysical survey shall cover the mooring area and approaches, and the pipeline route corridor, with all survey lines conducted with continuous bathymetric soundings, seabed imagery and sub-seabed profiling.
 - a. All sensors should be towed concurrently.
 - b. Depending on the site conditions, e.g., in case metal debris/dropped objects or UXO (bombs/mines) are encountered on the seafloor, the need for a magnetometer survey should be verified.

As an alternative to the single beam echo-sounder, a multi-beam echo-sounder may be used, provided it is demonstrated that the survey performance requirements can be met to a comparable quality level.
8. The geotechnical survey shall be conducted after the satisfactory completion of the geophysical survey and the confirmation of the system lay-out and pipeline route corridor.
 - a. Geotechnical sampling and in-situ testing equipment shall be selected suitable for the soil conditions expected.
 - b. The target depths shall be assessed based on the design of the anchor points, PLEM foundation and pipeline.

3.7 PRODUCT DATA

1. The Principal will provide product data, including minimum and maximum values of all relevant parameters using the extreme or the most unfavourable value for design analysis.
2. As a minimum, the following product parameters should be provided:
 - a. temperature;
 - b. pressure;
 - c. density;
 - d. viscosity;
 - e. pour point;
 - f. flash point;
 - g. water content;
 - h. H₂S content;
 - i. wax point;
 - j. aromatics content;
 - k. toxicity.

3.8 INTERNAL CORROSION OF THE PRODUCT TRANSFER SYSTEM

1. The potential for internal corrosion of any product-carrying components including valves and fittings shall be assessed considering various products and fluids that may enter the pipeline during installation, operation, and maintenance and their potential interaction with the piping components.
2. If a potential for internal corrosion is identified, the following shall be considered:
 - a. a corrosion allowance;
 - b. an internal coating system;
 - c. operation and maintenance procedures that minimize corrosion potential, such as flushing and filling with non-corrosive product between operations;
 - d. the use of a corrosion inhibitor;
 - e. the use of corrosion resistant materials.

3.9 VESSEL DATA

1. Vessel data for the entire range of calling vessels shall be considered for the design of the SPM system.

3.10 THROUGHPUT REQUIREMENTS

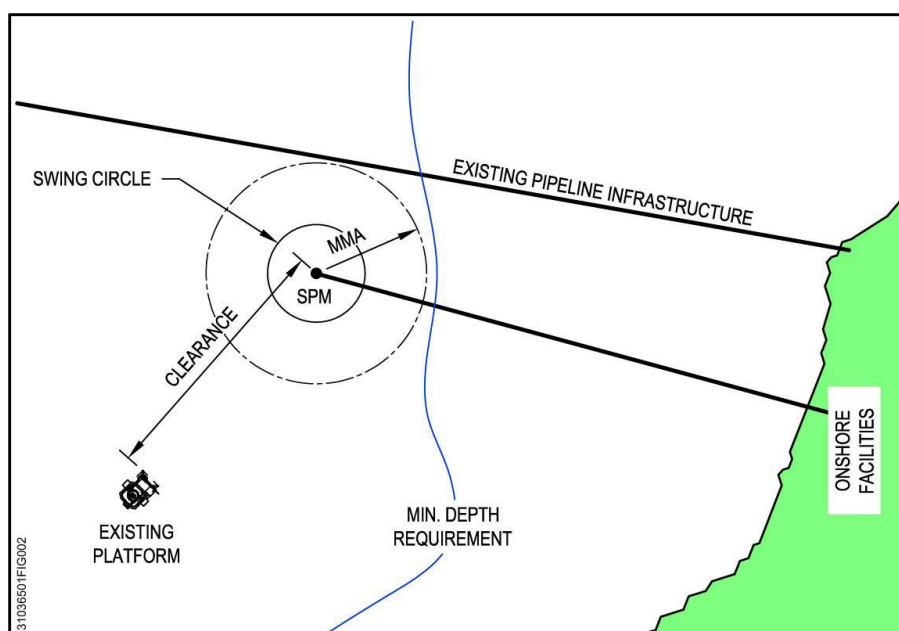
1. Minimum, average and maximum throughput values together with product transfer times shall be considered for the sizing of the SPM product transfer system and pipeline(s).

3.11 SYSTEM LAY-OUT

1. The swing circle shall be defined, together with the required minimum depth.

The swing circle comprises the area used by the vessel when connected to the buoy, considering vessel and hawser length, hawser elongation, buoy excursion, and a safety clearance.
2. The MMA including approach and departure routes shall be defined, together with the required minimum depth, considering the height of the pipeline and any other potential obstructions.
 - a. If an existing seabed infrastructure or any obstruction cannot be avoided the risk shall be assessed and mitigating measures implemented as required;
 - b. The subsea pipeline should follow a straight route within the MMA.
3. A clearance area SHALL [PS] be established taking account of the need for adequate maneuvering room around the SPM buoy determined by a risk/consequence assessment.

Guidance for this risk/consequence assessment is provided by OCIMF Single Point Mooring Maintenance and Operations Guide.

Figure 1 System layout criteria

4. DESIGN LOADS

4.1 ENVIRONMENTAL LOADS

1. The design of the mooring system and primary structure of the buoy SHALL [PS] include the following design cases:
 - a. the buoy with a tanker moored exposed to operational environmental conditions;
 - b. the buoy only (excluding moored tanker) exposed to survival environmental conditions;
 - c. the buoy only (excluding moored tanker) exposed to survival environmental conditions with loss of any one mooring leg.
2. Components of both the mooring and the product transfer systems shall be assessed for transferring of loads, such as tension, compression, torsion and bending on the interfaces between hoses and the buoy and between hoses and the PLEM, as well as on the hose strings themselves.
3. Analyses shall consider the directional combinations of wind, wave and current for the range of design vessels.
4. The SPM buoy shall be designed for nominal mooring loads of at least 4000 kN (900 kips).

4.2 TOWING/TRANSPORTATION LOADS

1. Towing/transportation loads and load transfer directions shall be established and considered in the design of the buoy.

4.3 ACCIDENTAL LOADS

1. The magnitude and frequency of accidental loads to be considered shall be determined by risk analysis and a surge analysis (5.2.1, Item 4).

5. SPM DESIGN AND FABRICATION**5.1 GENERAL**

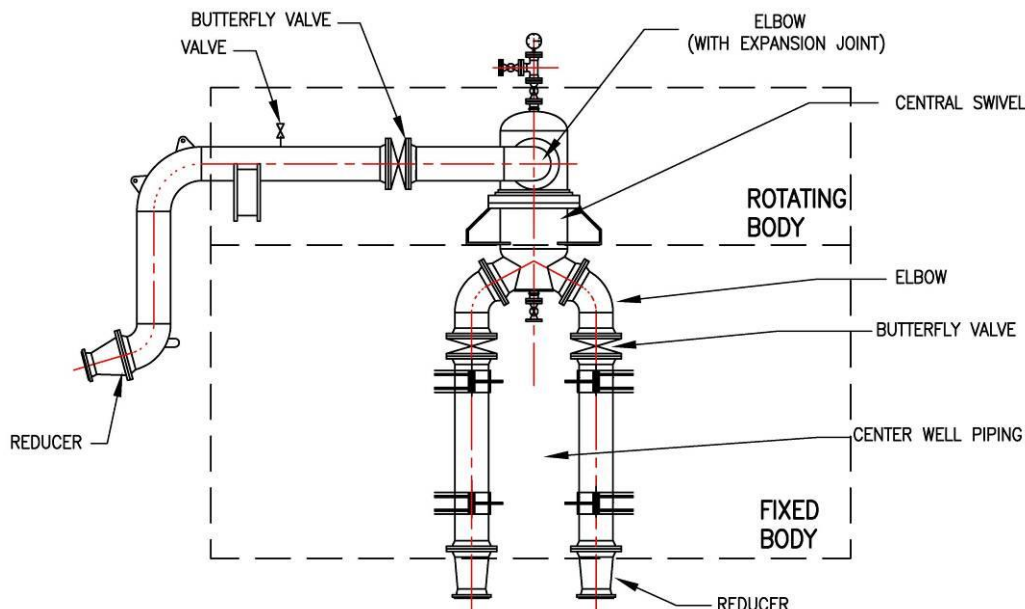
1. All fabricated, manufactured, and/or supplied materials, equipment and components shall be qualified of proven design, with minimum three years' operating experience.
2. Prototypes, new designs, or extensive modification of standard designs shall not be used without the written consent of the Principal.

5.2 PRODUCT TRANSFER SYSTEM**5.2.1 General**

1. The product transfer system shall be developed in accordance with the Process Engineering Flow Scheme (PEFS) and the specified piping class and shall be designed for product pressure loads, thermal loads and external loads such as environmental loads (8)&(9).
2. A steady-state hydraulic analysis shall be performed to determine the normal operational conditions and associated pressures, the required line sizes, and the pump capacity.
3. A surge analysis SHALL [PS] be performed to establish peak system pressures of the complete product transfer system (modelled from tank to tank), recognizing the maximum allowable incidental pressures of all system components (piping, pipeline, hose string).
4. The surge analysis shall be performed for the following upset conditions as a minimum:
 - a. accidental valve closure;
 - b. closure of breakaway coupling;
 - c. pump shutdown;
 - d. ESD.
5. The surge analysis should establish marine breakaway coupling settings with associated pressures and releases.
6. Mitigation of any product release may be considered through operational procedures.
7. The product transfer system design shall consider hawser failure scenarios.
8. Thermal effects shall be considered to determine thermally induced stresses and pressures and the need for pressure relief systems.
9. If different pressure ratings are employed through the system, the pressure rating transitions shall be defined.
10. Floating and submarine hoses shall comply with the requirements of DEP 37.91.20.30-Gen.
11. SPM and PLEM piping shall comply with the requirements of DEP 31.38.01.11-Gen. and DEP 31.38.01.15-Gen.
12. Use of marine breakaway couplings (MBCs) may be considered based on HAZOP results.

5.2.2 SPM product piping

1. A typical piping arrangement for a turntable type buoy is shown in Figure 2 below.

Figure 2 Typical piping arrangement for turntable type buoy

2. The SPM piping shall have a constant diameter, with any reducers to be placed immediately after the floating and submarine hose connections.
3. The piping wall thickness shall not be less than 12.7 mm (1/2 in) (or 11.1 mm (3/8 in) for piping sizes DN 100 (NPS 4) and smaller).
4. The stresses in the supports, seats and brackets of the piping due to working pressure, test pressure, thermal expansion, and exterior forces exerted by the hose strings should be calculated.
5. A doubler plate of same thickness as the connecting piping /plate shall be provided at each location where a pipe or plate is welded directly on to the piping.
6. The piping shall be configured such that flanged fittings and gaskets can be removed and replaced without forcing the flange faces apart.
7. Temporary blinds shall be installed to protect the flanges and pipework during transportation.
8. All the spools required to connect the hoses shall be pressure tested.
9. Spools shall be removed during r transportation of the SPM buoy to avoid damage.
10. All the piping sections shall be suitable for replacement in-situ.
11. In case of a dual line system, the second piping path shall remain operable when the first piping path is being replaced.

5.2.3 Centre well piping

1. The centre well piping shall be accessible for maintenance/repair by divers from the top and the bottom of the centre well.
2. The piping shall be secured and connected to the centre of the fixed part with a minimum of two pipe clamps, per pipe section.
3. Blind flanges shall:
 - a. be fitted to the buoy piping end flanges and spool piece flanges;
 - b. have two handles of round bars welded on the outer edges to facilitate handling under water;
 - c. be supplied complete with bolts and gaskets.
4. The piping shall consist of the following components which are described in sequential order from the central swivel to the submarine hoses:
 - a. two elbow pieces ending in raised face (RF) flanges;
 - b. two wafer type butterfly valves in the centre well sized to allow ease of removal with the buoy in-situ;
 - i. the butterfly valves are gearbox operated with an extended rod and handwheel protruding above the top platform of the centre well, allowing the valves to be opened or closed without entering the centre well.
 - c. two centre well pipes leading from the butterfly valves to two flanges at the bottom end, terminating above the buoy hull bottom contour and having provision for pipe movement during valve change-out;
 - d. two spool pieces/reducers connecting to the centerwell piping with lifting lugs on the spool piece for use during hose installation.
5. For each spool piece referred in 4. (d), the upper flange of the spool piece shall be a lap joint flange with a stop to prevent the ring sliding down during installation.
6. Appropriate joints should be made in the pipework to facilitate removal.

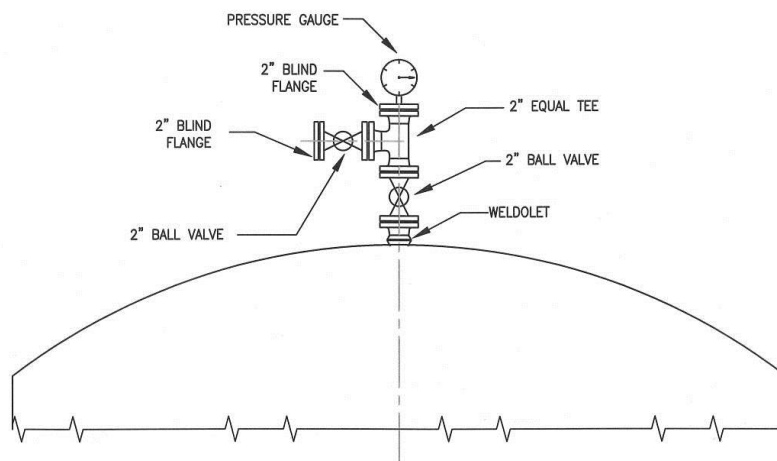
5.2.4 Central swivel unit

5.2.4.1 General

1. The central swivel head shall follow the movement of the rotating part by means of a driving plate structure.
2. The swivel seals and the bearing shall be able to be inspected and replaced in-situ.
3. The central swivel shall be fitted with lifting lugs, jacking points and guide pins to allow swivel component disassembly and reassembly.
4. The central swivel shall have flat face weldneck (FFWN) flanged connections to the flexible joints.
5. The swivel shall be designed for operation with one flexible joint and one blind nozzle of the rotating part.
6. The piping loads from the flexible joints shall be supported by rigid support on the rotating part.
7. Tension bars across the flexible joints shall not be used.
8. For draining and flushing both the fixed part and the rotating part shall be provided with a 50 mm (2 in) flanged nozzle with ball valve and blind flange.
9. A test and monitoring manifold shall be fitted on top of the swivel.
10. The pressure gauge shall be glycerine filled and be in accordance with DEP 32.31.00.32-Gen.

11. Lifting lug shall be fitted to the swivel rotating part.
12. A protection frame shall be fitted to the lifting lugs over the test and monitoring arrangement.

Figure 3 Swivel test and monitoring arrangement



5.2.4.2 Sealing arrangement

1. The central swivel shall be fully protected against the ingress of seawater by an external self-energizing seal with the external seal fitted in stainless steel housing and having an Inconel running face.
2. Two internal product seals, a primary seal and a secondary seal, shall be housed in a stainless steel containing ring.
3. The running face of the two lip seals shall be an Inconel overlay with seal running surfaces finished to be within the roughness limit set by the seal Manufacturer.
4. The clearance between the seals running face and the underside of the stainless steel containing ring shall be limited to 0.15 mm (3/500 in) minimum and 0.3 mm (3/250 in) maximum.
5. The swivel seal housing shall be located at the bottom, in the fixed part, for ease of maintenance or replacement.

5.2.4.3 Leak detection

1. One leak detection port between the primary and the secondary seal shall be provided to detect any leakage between the two lip seals.
2. The leak detection port shall have a 6.35 mm (1/4 in) National Pipe Thread (NPT) thread and a stainless steel needle valve.

5.2.4.4 Swivel bearing arrangement

1. The bearing shall be provided with 18 equally distributed grease holes fitted with grease nipples in accordance with (5.8.6).
2. Three grease relief ports shall be provided with 12.7 mm (1/2 in) NPT thread and check valve.

5.2.5 Rotating part piping

5.2.5.1 General

1. The piping on the rotating part shall be designed such that the complete system can remain operational with one branch damaged (in case of a dual hose system).
 - a. For this purpose, the branches should be equipped with the relevant valves and optionally with spectacle blinds.

5.2.5.2 Flexible joints

1. Rubber flexible joints shall be provided between the flanges of the central swivel and the elbow flanges.
2. The joints shall be designed for easy removal by means of removable turnbuckles.
3. The flange-to-flange length of the rubber flexible joints shall be 0.6 m (2 ft) unless otherwise specified.
4. The flexible joints shall be designed to withstand an internal vacuum of 70 kPa (10 psi) without impairing their resistance to internal pressure.
5. The flexible joints shall be product- resistant, seawater-resistant and ultra-violet light-resistant, and be protected by canvas covers.

5.2.5.3 Valves on the rotating part

1. Handwheels of manually operated valves shall be in the vertical position.

5.2.5.4 Piping on the rotating part

1. The elbows shall be provided with supports that can absorb the internal pressure loads produced by the piping system and the pipe weight.
2. Pipework shall be provided with wire guides for floating hose string handling.
3. Straight spools ending in raised face weldneck (RFWN) flanges connected to the lower flanges shall be provided with two lifting lugs and wire guides for hose handling.
4. The length of these straight spools shall be determined after the ballast calculation is finalised, such that the centres of the connecting floating hose flanges are at the water line.

5.2.6 Valves and actuators

1. Refer DEP 31.38.01.15-Gen. for requirements of Buoy valves
 - a. These valves should be provided with a gearbox and hand wheel for manual operation, unless specified differently, and have adequate protection against seawater corrosion and ingress of seawater at the stem and the gearbox.
2. Butterfly valves shall have “fail-to-open” position characteristics for a failing disc to spindle connection.
3. Manual valve actuators shall be provided with locking devices for the open and closed position.
4. All valves shall be provided with position indicators.
5. Refer DEP 31.36.00.30-Gen. for Subsea valves.
6. Refer DEP 32.36.01.18 Gen. for Quarter-turn on/off actuators.

5.2.7 Hose design, construction and testing**5.2.7.1 General**

1. The design, manufacturing and testing of the hoses shall be per OCIMF "Guide to Manufacturing and Purchasing Hoses for Offshore Moorings".
2. Refer DEP 37.91.20.30-Gen. and MESC 73.15.31 or MESC 73.15.37 as applicable for requirements of hoses.
3. The hose configuration, length, and hose type for both the submarine and floating hoses shall be based on the design water depths (including variations), environmental loading, and the full range of tanker sizes.
4. The submarine hose and floating hose analyses and arrangement designs shall be endorsed by the hose Manufacturer/Supplier.
5. The hose Manufacturer shall be part of the TAMAP list.

5.2.7.2 Submarine hose arrangement

1. ISO 13628-11:2007 Clause 8 should be used as guidance for the design of the submarine hose arrangement.
2. The submarine hose configuration SHALL [PS] be analysed to demonstrate clearance of the hose to seabed, chains, other hoses or any other body under all conditions.
3. The configuration analysis shall consider the installation tolerances for the PLEM and buoy.
4. The hose bend radii shall not be less than those specified by OCIMF "Guide to Manufacturing and Purchasing Hoses for Offshore Moorings".
5. In case the submarine hose arrangement comprises a buoyancy tank, the buoyancy shall be adjustable by partial flooding and emptying of the buoyancy tank.

5.2.7.3 Floating hose arrangement

1. The floating hose string shall have a total length suitable for the range of vessels expected.

5.2.7.4 Marine break away couplings

1. MBCs, if applied, shall conform to the principles of OCIMF "Marine breakaway couplings".
2. MBCs shall be a double closure type, be fitted in the floating part of the tail hose section near the tanker manifold, and be provided with a dedicated floatation collar.
3. The parting load setting of the MBC shall be established above its operational loads and design pressure and within the limits of the maximum allowable hose tensions and maximum allowable (surge) pressures.

5.2.7.5 Hose ancillary equipment

1. The tanker end of a rail hose shall be equipped with the required ancillary equipment specified by the OCIMF "SPM hose ancillary equipment guide" and in accordance with MESC SPE 53.05.75/001.

5.2.8 Surge relief system

1. In case surge pressures cannot be accommodated in the product transfer system, a pressure relief system shall be designed in accordance with DEP 31.40.00.10-Gen.
2. The discharge of oil from the product transfer system shall be to a dedicated surge relief vessel mounted at the rotating or fixed part of the buoy.
3. The relief system shall be provided with a pump to drain the surge relief vessel content back into the product transfer system.