

DEP SPECIFICATION

SINGLE POINT MOORING (SPM) SYSTEMS

DEP 37.91.10.10-Gen.

February 2011

(DEP Circular 33/12 has been incorporated)

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP gives minimum specification and requirements for the design, manufacture, construction, and installation of a CALM type SPM system.

Two main types of CALM buoy design are the turntable type and the turret type. The selection for a CALM type SPM system shall be based on a review of site and operating conditions.

The requirements in this DEP apply to both turret and turntable type SPM's 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 January 2010; see (1.5) regarding the changes.

**Amended per
Circular 33/12**

A number of editorial (non-technical) changes have been made throughout this DEP.

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 marine floating terminal systems in shallow water, less than 50 m (164 ft) deep. Systems for deeper waters shall 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 should 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, 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.

1.3.2 Abbreviations and symbols

ABS	American Bureau of Shipping
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
CP	Cathodic Protection
DFT	Dry Film Thickness
ERP	Emergency Response Plan
ESD	Emergency Shut-Down
FF	Flat or Full Face
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HEMP	Hazard Effect Management Process
Hmax	Maximum Wave Height
Hs	Significant Wave Height
HPU	Hydraulic Power Unit
HSSE	Health, Safety, Security, and Environment
ISO	International Organization for Standardization
ITP	Inspection and Test Plan
LTM	Long Term Mooring
MBC	Marine Breakaway Coupling
MESC	Materials and Equipment Standards and Code
MMA	Mooring and Maneuvering Area
NDE	Non-Destructive Examination
NPT	National Pipe Thread

OSR	Oil Spill Response
OU	Operating Units
PEFS	Process Engineering Flow Scheme
	Note: Some companies use the term P&ID (Piping & Instrumentation Drawing) synonymously
PFS	Process Flow Scheme
PLEM	Pipe Line End Manifold
QA/QC	Quality Assurance/Quality Control
RF	Raised Face
SIAM	Shell Infrastructure Asset Management
SPIR	Spare Parts Interchangeability Record
SBM	Single Buoy Mooring (in this document referred to as SPM)
SPM	Single Point Mooring (in this document of the CALM type)
SWL	Safe Working Load
UXO	Unexploded Ordnance

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section 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 January 2010. In this revision, content that was background information, explanation and guidance, and therefore not required to be communicated to the Contractor, has been removed. Furthermore, all process safety requirements have been reviewed, and confirmed or modified accordingly.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://swwww.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

**Amended per
Circular 33/12**

Dual units have been incorporated throughout this DEP.

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.

2. CONCEPT AND PHILOSOPHIES

2.1 GENERAL

This section identifies key functional requirements for the development of the SPM system concept, essential for design, manufacture, construction, operation and maintenance. The contractor, in consultation with the principal, shall layout and documents the concept prior to further implementation of the project.

At least the following shall be established and documented by the Contractor:

- HSSE philosophy (2.2);
- Operation and maintenance philosophy (2.3);
- Quality philosophy (2.4);
- Design philosophy (2.5);
- Third party interaction (2.6);
- Availability analysis (2.9);
- Emergency shut down philosophy (2.7);
- Control and monitoring philosophy (2.8);
- Spare parts philosophy (2.10).

2.2 HSSE PHILOSPHY

An overall safety philosophy shall be established and implemented through all phases of the project from its initiation through to operation. This safety philosophy shall follow the Principal's safety policy with particular focus on the following elements:

- The system shall not cause hazards to activities in the area of the system, including the users of the system, support activities, or third party activities;
- The impact on the environment shall be minimized as far as reasonably practicable from installation through operation to de-commissioning.

A systematic review shall be performed during each phase of the project. The systematic safety review shall include activities such as HAZID, HAZOP, HEMP, and Risk Assessment. Such reviews shall also be performed during the operational phase whenever there is a change.

The risk assessment shall show all risks to be As Low As Reasonably Practicable (ALARP).

As a minimum the risk assessment shall cover complete failure or partial failure of the following main functional systems:

- Product transfer system;
- Mooring load transfer system;
- Buoyancy system;
- Rotation system;
- Safety system;
- Navigation aids, electrical and control system;
- Maintenance support system.

2.3 OPERATIONS AND MAINTENANCE PHILOSOPHY

2.3.1 General

The operational and maintenance philosophy shall:

- Convey information for design, engineering and manufacturing of the planned SPM system;
- Provide the basis for the SPM buoy operation and maintenance manual;
- Provide the basis for the SPM terminal marine operation manual.

In the concept development phase, an operation and maintenance philosophy shall be established that forms the basis of following

- SPM terminal availability requirement
- SPM system availability requirement considering the system component availability;
- Maintenance and component replacement intervals;
- Sparing philosophy
- System overhaul frequency;
- Inspection, maintenance, tools and vessels;
- Marine operations considering the operational window for mooring and de-berthing manoeuvring, piloting, requirements for tug support, etc.;
- Pump, pipeline, product characteristics and flow direction
- Definition of operating and maintenance facilities such as storage for spares, maintenance workshop, hose string make-up site, control room;
- Requirement for shore based support facilities, such as waterfront access, hose ramp, equipment storage and cover, mooring facility for work boats, workshop;
- Design pressure, operating pressure and surge;
- Flow control for start-up, normal operation, normal shutdown and emergency shutdown;
- Valve operation, means, frequency, location, i.e., local or remote for SPM and PLEM, manual or actuated;
- Number of products;
- Pigging requirements and operations;
- Flushing;
- Diving operations;
- System interfaces;
- Fire fighting requirements;
- Oil spill containment / pollution mitigation requirements.

2.3.2 Product transfer philosophy

- The characteristics of the product shall be taken into consideration.
- For the transfer of different products through a single SPM system a philosophy shall be developed for the transfer method.

2.3.3 Flushing philosophy

The flushing philosophy for the terminal product transfer system shall be established to provide the basis for the lay-out of the PLEM and SPM.

Following shall be established:

- Flushing fluid to be used

- Flushing direction
- Flushing process monitoring concept
- Flushing facilities such as valves, tie-in points, by-passes etc.

2.3.4 Pigging philosophy

A pigging philosophy shall be established addressing the operational and non-routine pigging operations. The PLEM configuration shall consider the pigging requirements.

DEPs which address specific aspects of pigging are:

- pre-commissioning of pipelines: DEP 31.40.50.30-Gen.
- pipeline engineering: DEP 31.40.00.10-Gen.
- piping – general requirements: DEP 31.38.01.11-Gen.

2.3.5 Process Flow Scheme (PFS)

The product transfer system concept shall be laid down in a functional lay-out, typically in the form of a PFS.

The contractor shall consider the various piping options available and present to the principal a clear rationale for the selected lay-out based on the operating and maintenance, control and monitoring and pigging philosophies.

The PFS shall indicate the main components and main line sizes of the complete product transfer system and reflect related philosophies and the intended operating method. The PFS should show the following:

- buoy piping lay-out;
- swivel lay-out;
- PLEM piping lay-out
- PLEM pigging arrangement;
- submarine hose arrangement;
- floating hose arrangement;
- spool pieces with piping to hose diameter transitions;
- redundancy in product transfer system, submarine hoses, swivel paths, floating hoses;
- operational valves;
- valve type and operator;
- maintenance isolation valves;
- ESD valve arrangement;
- crossovers and bypasses;
- system safeguards such as surge relief and Marine Breakaway Couplings;
- Battery limits

2.3.6 Marine operations philosophy

Marine operations parties should be involved at an early stage in the SPM terminal development and SPM buoy specification.

Marine operations philosophy shall establish the following:

- SPM terminal maintenance support vessel fleet operation- The need for and extent of the deployment of supporting vessels

- Tanker mooring and cargo transfer support operations -
 - Requirement of tug support during approach and manoeuvring;
 - Definition of approach and departure routes;
 - Requirement of navigation buoys;
 - Definition of Anchorage area;
 - Definition of exclusion zone;
 - Pilotage requirements and philosophy;
 - Cargo transfer operation philosophy;
 - Communication between SPM and tanker;
 - Emergency and OSR philosophy

2.4 QUALITY PHILOSOPHY

Throughout the project a quality assurance system shall be implemented in accordance with ISO 9001 or as elsewhere described.

2.5 DESIGN PHILOSOPHY

A consistent framework of design codes shall be mandated at the initiation of the project. The design code framework shall address all relevant design conditions and define engineering and design standards. The design code framework shall address all components of the system.

This DEP complements the requirements of such design codes by defining specific requirements.

2.6 THIRD PARTY INTERACTION

Third party activities in the area shall be considered, and incorporated in the design operations and risk assessment. The risk assessment shall address both the risk from third party activity to the system and the risk from the system to existing third party users.

Mitigating measures identified in the risk assessment shall be implemented.

2.7 EMERGENCY SHUT DOWN PHILOSOPHY

Based on risk assessment on emergency shutdown, the need for an Emergency Shut Down (ESD) system shall be established.

The risk assessment on emergency shutdown shall be based on the system risk assessment, considering all relevant aspects such as product type, system utilization, site conditions, and location characteristics.

The ESD system shall be independent of the normal operating system. The components shall be identified, and an interface and control mechanism defined. The ESD system will typically comprise an ESD valve on the PLEM, and be interfaced with the overall control system. DEP 31.36.10.30-Gen. shall be considered.

2.8 CONTROL AND MONITORING PHILOSOPHY

2.8.1 General

The control and monitoring philosophy shall be developed in conjunction with the operation and maintenance philosophy (2.2) and ESD philosophy (2.6). The control and monitoring philosophy shall be laid down in a preliminary instrumentation and control block diagram.

The control and monitoring philosophy shall establish:

- data to be measured and recorded, without real time transfer to the control system (no signals, possible local recorder);
- data to be measured and transferred in real time to the control system (passive signals);
- data to be transferred from the control system to the system and method of interface (active signals);
- operation and read-out locations.

2.8.2 Data communication philosophy

If the control and monitoring philosophy requires remote readout and/or operation, a data communication philosophy shall be established.

For telemetry systems, tanker shadowing between the transmitter and receiver station shall be considered.

2.8.3 Power philosophy

A power philosophy shall be established considering the emergency shut down philosophy, control and monitoring philosophy, data communication philosophy and a preliminary equipment load balance.

For systems with low power demand such as the navigation light only, battery replacement could be considered.

2.9 AVAILABILITY ANALYSIS

An availability study shall be performed to determine the availability distribution of the SPM terminal.

2.10 SPARE PARTS PHILOSOPHY

A sparing philosophy shall be developed considering operations and maintenance philosophy in accordance with DEP 70.10.90.11-Gen.

3. DESIGN DATA

The Principal shall determine and provide the following to the manufacturer of SPM.

3.1 SYSTEM DESIGN LIFE

The Principal shall define the system design life.

3.2 BATTERY LIMITS AND SYSTEM INTERFACES

The battery limits for the SPM main functional systems shall be clearly defined considering the whole SPM terminal. The battery limits shall be defined with a view to minimizing interface complexity and reducing project development risks.

3.3 CLASSIFICATION / CERTIFICATION

The requirements for classification or certification of the system, if applicable, shall be specified.

3.4 ENVIRONMENTAL DESIGN CONDITIONS

The meteorological and oceanographic conditions, relevant for the design, installation and offshore operations, shall be described. The description shall include special conditions and observations that could affect the system. Reference shall be made to DEP 37.00.10.11.

3.5 SITE CONDITIONS

The site conditions shall be determined to adequate detail and accuracy for the selection of the system lay-out, confirmation of nautical safety, and the design of the pipeline and shore approach, PLEM, mooring system and anchor point.

The survey requirements shall be defined in detail in a survey scope of work and specification that will form the basis for the field work activities. This scope of work and specification shall define as a minimum the requirements for the following:

- Quality control;
- Survey procedures;
- Scope of survey activities;
- Data coverage;
- Horizontal and vertical datum;
- Positioning accuracy;
- Data quality and accuracy;
- Minimum vessel, equipment, and personnel requirements;
- Data analysis
- Interpretation, Reporting and documentation

The survey should comprise a geophysical survey, a geotechnical survey and bathymetry of the ship manoeuvring area and SPM surroundings, PLEM and pipeline. A shallow water shore approach survey shall ensure there is sufficient overlap between the onshore and offshore surveys. The offshore survey shall:

- Determine water depth in the approaches, in the MMA, and at the SPM location;
- Determine seabed features relevant for design and operations, such as outcrops, reefs, or obstacles;
- Determine surface and subsurface soil conditions and establish engineering properties and characteristics of the soils to a suitable depth for PLEM design, anchor point design, pipeline stability, and trenching;

The geophysical survey shall cover the mooring area and approaches, and the pipeline route corridor. All survey lines shall be conducted with continuous bathymetric soundings, seabed imagery and sub-seabed profiling. Preferably all sensors are towed concurrently. As an alternative to the single beam echo-sounder a multi-beam echo-sounder can be used, provided it is demonstrated that the survey performance requirements can be met to a comparable quality level. 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 shall be verified.

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. Geotechnical sampling and in-situ testing equipment shall be selected suitable for the soil conditions expected. The target depth of any sampling shall be sufficient for detail anchorage design of the mooring.

3.6 PRODUCT DATA

The Principal shall provide all product data including minimum and maximum values of all relevant parameters. The extreme or the most unfavorable value shall be used for design analysis. As a minimum, following product parameters shall be provided:

- Temperature;
- Density;
- Viscosity;
- Pour point;
- Water content;
- H₂S content;
- Wax point;
- Aromatics content.

3.7 INTERNAL CORROSION OF THE PRODUCT TRANSFER SYSTEM

The potential for internal corrosion of any product-carrying components shall be assessed. The various products and fluids that may enter the pipeline during installation, operation, and maintenance and their potential interaction with the piping components shall be reviewed. Attention shall be given to valves and fittings. If a potential for internal corrosion is identified, the following shall be considered:

- a corrosion allowance;
- an internal coating system;
- operation and maintenance procedures that minimize corrosion potential, such as flushing and filling with non-corrosive product between operations;
- the use of a corrosion inhibitor;
- the use of corrosion resistant materials.

3.8 VESSEL DATA

Vessel particulars for the entire range of calling vessels shall be provided for the design of the SPM system.

3.9 THROUGHPUT REQUIREMENTS

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

3.10 SYSTEM LAY-OUT

- 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.
- The MMA shall be defined, together with the required minimum depth. The water depth requirement shall consider the height of the pipeline and any other seabed features. The subsea pipeline should follow a straight route within the MMA.
- The system shall be positioned so that there are preferably no other pipelines or seabed infrastructure within the MMA or on the approach and departure routes. If an existing seabed infrastructure cannot be avoided the risk shall be assessed and mitigating measures implemented as required.
- A clearance area SHALL [PS] be established that is applicable to navigation in the area. Normally one nautical mile radius from the SPM is used as base case, or otherwise dependent on the situation.

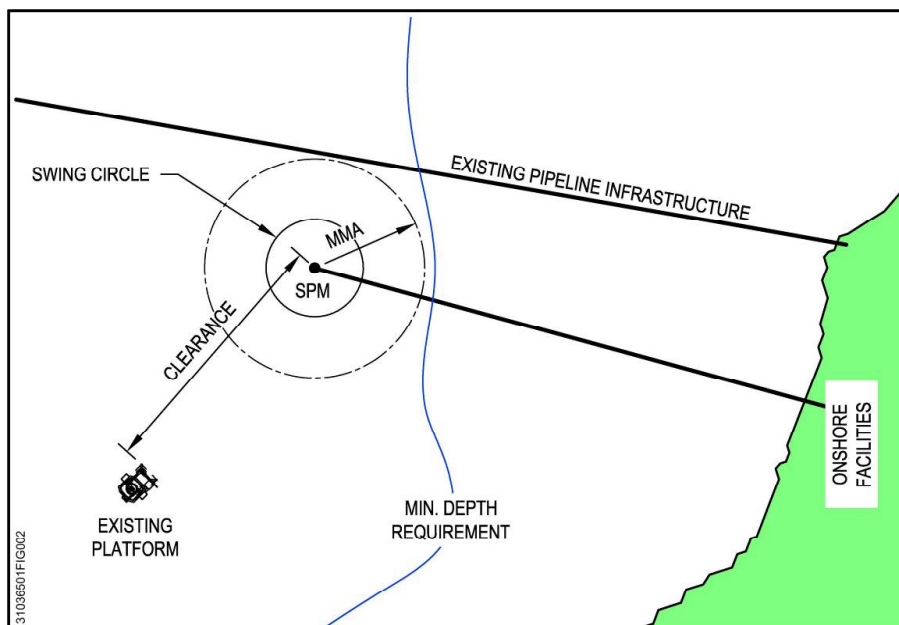


Figure 1 – System Layout Criteria

4. DESIGN LOADS

4.1 ENVIRONMENTAL LOADS

The environmental loads shall be determined using an accepted load model in accordance with the selected design code.

The design of the mooring system and primary structure of the buoy SHALL [PS] include the following design cases:

- The buoy with a tanker moored exposed to operational environmental conditions;
- The buoy only (excluding moored tanker) exposed to survival (100 year) environmental conditions;
- The buoy only (excluding moored tanker) exposed to survival (100 year) environmental conditions with loss of any one mooring leg.

Load transfers shall be assessed, in particular for the components of the mooring system and product transfer system, such as forces and bending moments on the interfaces between hoses and buoy and between hoses and PLEM.

Analyses shall consider the various directional combinations of wind, wave and current for the range of design vessels.

The SPM buoy shall be designed for nominal mooring loads of at least 4000 kN.

4.2 TOWING/ TRANSPORTATION LOADS

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

4.3 ACCIDENTAL LOADS

Credible accidental loads shall be considered in a risk analysis and the magnitude and frequency of the accidental loads shall be established.

5. SPM DESIGN AND FABRICATION

5.1 GENERAL

All the materials, equipment and components fabricated, manufactured and / or supplied shall be of proven design, typically a minimum three years operating experience. Prototypes, new designs, or extensive modification of standard designs are unacceptable without the written consent of the Principal.

5.2 PRODUCT TRANSFER SYSTEM

5.2.1 General

- The product transfer system shall be developed in accordance with the PEFS and the specified piping class
- The product transfer system shall be designed for product pressure loads, thermal loads and external loads such as environmental loads.
- 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.
- A surge analysis shall be performed to establish peak system pressures for following upset conditions as a minimum
 - i. (Accidental) valve closure
 - ii. Closure of breakaway coupling
 - iii. Pump shut down, and
 - iv. ESD
- The surge analysis should establish marine breakaway coupling settings with associated pressures and releases. Mitigation through operational procedures can be considered.
- The consequences of hawser failure scenarios shall be considered in the product transfer system design.
- Thermal effects shall be considered to determine thermally induced stresses and pressures and the need for pressure relief systems.
- The pipe pressure rating shall be based on the hydraulic analysis and external loads. Pressure rating limitations in industry standard products shall be considered.
- If different pressure ratings are employed through the system the pressure rating transitions shall be unambiguously defined and verified.
- Floating and submarine hoses shall comply with the requirements of DEP 37.91.20.30-Gen.
- SPM and PLEM piping shall comply with the requirements of DEP 31.38.01.11-Gen. and DEP 31.38.01.15-Gen.
- The ESD system shall be designed as per DEP 31.36.10.30-Gen.
- MBC (Marine Breakaway Coupling) is optional based on HAZOP results.

5.2.2 SPM product piping

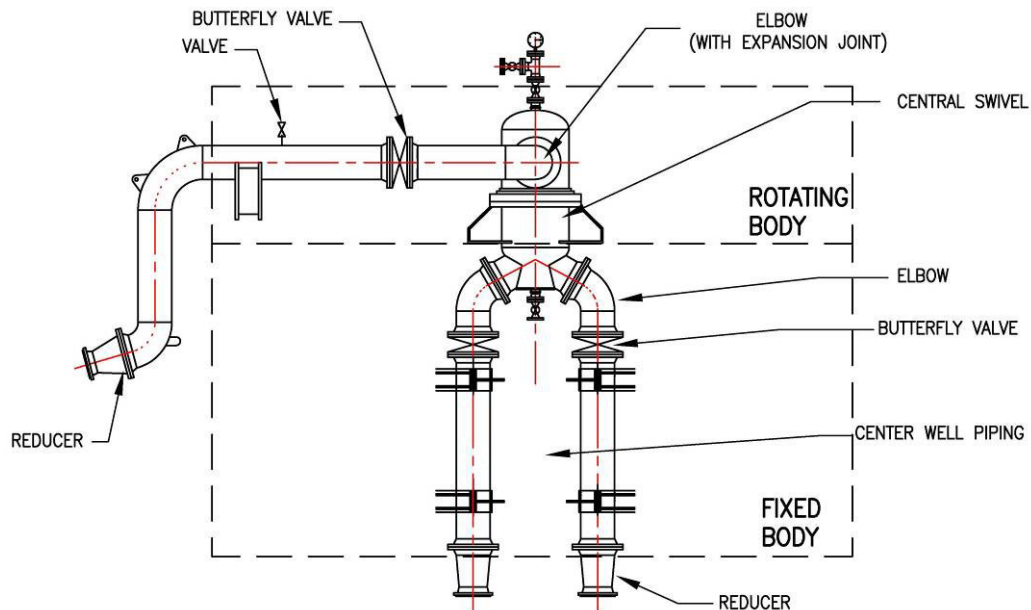


Figure 2: Typical buoy piping arrangement

- The SBM piping shall have a constant diameter, with any reducers to be placed immediately after the floating and submarine hose connections.
- 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).
- 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 shall be calculated. A doubler plate shall be provided at each location where a pipe or plate is welded directly on to the piping. Doubler plates shall have the same thickness as the piping.
- The piping shall be configured such that flanged fittings and gaskets can be removed and replaced without forcing the flange faces apart.
- Temporary blinds shall be installed to protect the flanges and pipework during transportation.
- All the spools required to connect the hoses shall be supplied, pressure tested and removed for transportation.
- All the piping sections shall be suitable for replacement in-situ. In case of a dual line system the second piping path shall remain operable.

5.2.3 Centre well piping

- The centrewell piping shall be accessible for maintenance/repair by divers from the top and the bottom of the centre well.
- The piping shall be firmly connected to the centre of the fixed part with a minimum of two pipe clamps, per pipe section.
- Blind flanges shall be fitted to the buoy piping end flanges and spool piece flanges. Blind flanges shall have two handles of round bars welded on the outer edges to facilitate handling under water and shall be supplied complete with bolts and gaskets.
- The piping shall consist of the following components which are described in

sequential order from the central swivel to the submarine hoses:

- Two elbow pieces ending in Raised Face (RF) flanges;
- Two wafer type butterfly valves in the centre well which shall be sized such that removal is practical with the buoy in-situ. Appropriate joints shall be made in the pipework to facilitate removal. The butterfly valves shall be gearbox operated with an extended rod and handwheel. The handwheel shall protrude above the top platform of the centre well allowing the valves to be opened / closed without entering the centre well.
- Two centre well pipes leading from the butterfly valves to two flanges at the bottom end. The centre well pipes shall terminate above the buoy hull bottom contour. The two pipes shall be provided with bosses which restrict pipe movement during valve change-out.
- Two spoolpieces/reducers connecting to the centerwell piping. For each spoolpiece the upper flange of the spoolpiece shall be a lap joint flange. The lap joint shall have a stop to prevent the ring sliding down during installation. Lifting lugs shall be provided on the spoolpiece for use during hose installation.

5.2.4 Central swivel unit

5.2.4.1 General

- The central swivel head shall follow the movement of the rotating part by means of a driving plate structure.
- The swivel seals and the bearing shall be able to be inspected and replaced in-situ. The central swivel shall be fitted with lifting lugs, jacking points and guide pins to allow swivel components disassembly and reassembly.
- The central swivel shall have FF WN flanged connections to the flexible joints.
- The swivel shall be designed for operation with one flexible joint and one blind nozzle of the rotating part.
- The piping loads from the flexible joints shall be supported by rigid support on the rotating part. Tension bars across the flexible joints are not acceptable.
- 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.
- A test and monitoring manifold shall be fitted on top of the swivel. The pressure gauge shall be glycerine filled and further in accordance with DEP 32.31.00.32 Gen.
- Lifting lug shall be fitted to the swivel rotating part. A protection frame shall be fitted to the lifting lugs over the test and monitoring arrangement.

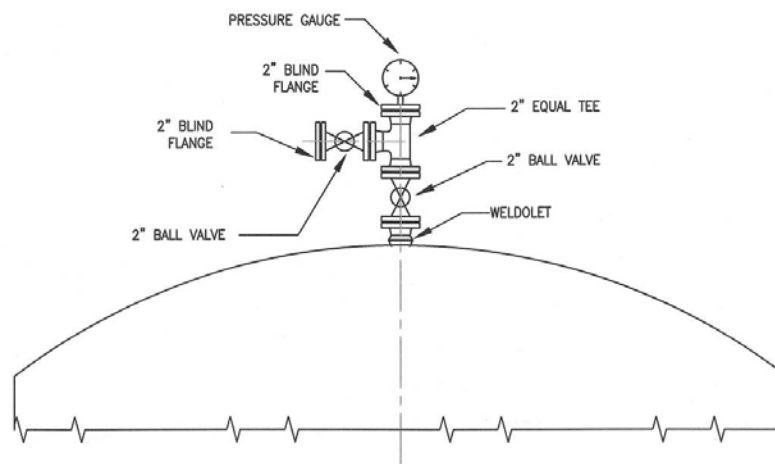


Figure 03: Swivel test and monitoring arrangement

5.2.4.2 Sealing arrangement

- The central swivel shall be fully protected against the ingress of seawater by an external large volume self-energizing seal. The external seal shall be fitted in a stainless steel housing and have an Inconel running face.
- Two internal product seals, a primary seal and a secondary seal, shall be housed in a stainless steel containing ring. The running face of the two lip seals shall be an Inconel overlay. The seal running surfaces shall be finished to within the roughness limit set by the seal manufacturer.
- 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.
- 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

One leak detection port between the primary and the secondary seal shall be provided to detect any leakage between the two lip seals.

The leak detection port shall have 6.35 mm (1/4 in) NPT thread and be provided with a stainless steel needle valve.

5.2.4.4 Swivel bearing arrangement

The bearing shall be provided with 18 equally distributed grease holes fitted with grease nipples in accordance with (5.8.6). 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

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). For this purpose the branches shall be equipped with the relevant valves and optionally with spectacle blinds.

5.2.5.2 Flexible joints

Rubber flexible joints shall be provided between the flanges of the central swivel and the elbow flanges. The design of the rubber flexible joints shall be such that easy removal will be possible (by means of removable turnbuckles). The flange-to-flange distance of the rubber flexible joint shall be approximately 0.6 m (2 ft) unless otherwise specified,

The flexible joints shall be capable of withstanding an internal vacuum of 70 kPa (10 psi) without impairing their resistance to internal pressure. The flexible joint shall be product-resistant, seawater-resistant and ultra-violet light-resistant. The flexible joints shall be protected by canvas covers.

5.2.5.3 Valves on the rotating part

The valves shall be in accordance with (5.2.6). Handwheels of manually operated valves shall be in the vertical position.

5.2.5.4 Piping on the rotating part

The elbows shall be provided with supports that can absorb the internal pressure loads produced by the piping system and the pipe weight.

Pipework is to be provided with sufficient wire guides for floating hose string handling.

Straight spools ending in RF WN flanges connect to the lower flanges and shall be provided with two lifting lugs and wire guides for hose handling. The length of these straight pipes shall be determined after the ballast calculation is finalised. The length shall be such that the centres of the connecting floating hose flanges are at water line.

5.2.6 Valves and actuators

Buoy valves shall comply with the requirements of DEP 31.38.01.15-Gen. Valves shall be provided with a gearbox and hand wheel for manual operation unless specified differently. Additionally, the valves shall have adequate protection against sea-water corrosion and ingress of sea-water at the stem and the gearbox.

Butterfly valves shall have "fail to open" position characteristics for a failing disc to spindle connection. Manual valve actuators shall be provided with locking devices for the open and closed position.

All valves shall be provided with position indicators.

Subsea valves shall comply with the requirements of DEP 31.36.00.30-Gen.

Quarter-turn on/off actuators shall comply with the requirements of DEP 31.40.70.30-Gen.

Supplementary requirements for the actuators shall be specified.

5.2.7 Hose design, construction and testing

5.2.7.1 General

The design, manufacturing and testing of the hoses shall be as per OCIMF "Guide to purchasing, manufacturing and testing of loading and discharge hoses for offshore moorings". Additionally, the hoses shall comply with the requirements of DEP 37.91.20.30-Gen and MESC 73.15.31 or MESC 73.15.37 as applicable.

The optimum hose configuration, length, and hose type for both the submarine and floating hoses shall be determined based on the water depth (including variations), environmental loading, and the full range of tanker sizes.

The submarine hose and floating hose analyses and arrangement designs shall be endorsed by the hose Manufacturer/Supplier.

The hose manufacturer shall be approved by the Principal.

5.2.7.2 Submarine hose arrangement

The most suitable submarine hose configuration shall be selected based on the site conditions and project requirements.

ISO 13628-11:2007 Clause 8 shall be used as guidance for the design of the submarine hose arrangement.

The submarine hose configuration SHALL [PS] be analyzed to demonstrate clearance of the hose configuration to seabed, chains, other hoses or any other body under all conditions. The hose bend radii shall not be less than those specified by OCIMF "Guide to