OISD STANDARD 139
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DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF OFFSHORE PIPELINES AND FACILITIES & DEEP WATER PIPELINES

Prepared by
FUNCTIONAL COMMITTEE ON “DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF OFFSHORE PIPELINES AND FACILITIES & DEEP WATER PIPELINES”

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ISO 9001:2008 certified
PREAMBLE

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 by Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than three decades of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate
FOREWORD

The Oil Industry in India is more than 100 years old. Because of various collaboration agreements, a variety of international codes, standards and practices have been in vogue. Standardization in design philosophies and operation and maintenance practices at a national level was hardly in existence. This coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasized the need for the industry to review the existing state- of- the-art in designing, operating and maintaining oil and gas installations.

With this in view, the Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council assisted by the Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardizing and upgrading the existing standards to ensure safe operations. Accordingly, OISD constituted a number of functional committees of experts nominated from the industry to draw up standards and guidelines on various subjects.

The standard was prepared by the Functional Committee on “Inspection of Pipelines - Offshore” and released in March 1990. Based on modification/changes/additions/amendments approved in the 19th Safety Council meeting, the standard was published with amendments in September, 2001.

To include aspects of offshore pipelines like design, construction, maintenance & inspection requirements in a single comprehensive standard, complete revision of this standard was carried out in this October’2017 publication, incorporating latest features from international & national standards and best practices with the objective to enhance safety in pipeline operations throughout its entire life cycle. This revision is made into two parts. Part-1 pertains to design, construction, inspection maintenance requirements of offshore hydrocarbon pipelines. Part-2 pertains to requirements of deep water pipelines.

This standard is meant to be used as a supplement and not as a replacement for existing codes and practices.

It is hoped that provisions of this standard, if implemented objectively, may go a long way to improve the safety and reduce accidents in Oil and Gas Industry. Users are cautioned that no standard can be substitute for the judgement of responsible and experienced Engineer.

Needless to mention, this standard, as always would be reviewed periodically based on field level experience, incident analysis and environment scanning. Suggestions from all stake holders are fervently solicited.

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Though every effort has been made to assure the accuracy and reliability of the data contained in these documents, OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from their use.

These documents are intended to supplement rather than replace the prevailing statutory requirements.

Where ever BIS standards are referred same relates to the latest version of the standard.

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# COMMITTEE ON DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF OFFSHORE PIPELINES AND FACILITIES & DEEP WATER PIPELINES

(October 2017 edition)

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In addition to the above, several other experts from the industry contributed in the preparation, review and finalisation of this document.

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DESIGN AND INSPECTION OF PIPELINES

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In addition to the above, several other experts from the industry contributed in the preparation, review and finalisation of this document.

* (Took over as Leader w.e.f June/89 on Shri Karode’s retirement from Oil India Ltd).

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# PART-1: DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF OFFSHORE PIPELINES AND FACILITIES

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PART-1: DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF OFFSHORE PIPELINES AND FACILITIES

1.0 Introduction

Safety in petroleum installations and pipelines comes through continuous efforts at all stages and as such it can be ensured by observing that installations and pipelines are designed, constructed and tested as per recognised engineering standards and that these are periodically inspected and maintained. Systems and procedures for carrying out inspection and maintenance go a long way in ensuring safe operation.

The objective of this document is to provide the basic parameters for design, construction, inspection and maintenance of offshore pipelines (rigid), Single Point Mooring system and associated facilities so that under specified operating condition, the potential risk of failure can be minimised, thereby ensuring safety of personnel, environment and /or asset value.

2.0 Scope

This standard outlines the minimum requirement for design, construction, inspection, testing, maintenance, modifications, corrosion protection, safety of offshore liquid & gas pipelines, Single Point mooring (SPM) system including associated facilities and installations as outlined in Annexure-I.

Effluent/ inlet water/ water injection line are also part of Offshore Pipelines.

The onshore portion of offshore pipelines, if any, shall be governed by OISD-141 / 214 for liquid transportation and OISD-STD-226 for gas transportation.

This standard shall be applicable from the date of issuance mentioned on the title page for all new projects/ extension or expansion/ modification of existing system. For existing facilities under operation, this standard shall be applicable for maintenance and inspection and minimum requirement shall be met within 2 (two) years of issuance of this standard.

This standard is not applicable for flexible pipelines.

3.0 Definitions

All definition / explanatory notes mentioned herein below shall be used for this standard.

Authorised person

A person or representative of the company trained and assigned to carry out a specific job.

Atmospheric Zone

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
The part of pipeline system above the splash zone.

Breakaway coupling

A component installed on the pipeline to allow the pipeline to separate, designed for instant closure and containment, when a predetermined axial load is applied to the coupling.

Competent Authority

Any person(s) appointed / authorized by Central Government for implementation of offshore rules.

Competent person

A person who is capable of identifying existing and predictable hazards associated with his area of activities and who has authorization to take prompt corrective measures to eliminate them.

Cold Work

It is an activity which does not produce sufficient heat to ignite a flammable mixture (mixture of flammable gas with an oxidising agent) or a flammable substance.

Design Factor

It is percentage factor of Specified minimum strength of the material considered for determining wall thickness based on location, service, applicable corrosion allowances and class of the pipeline.

Design Pressure

The resultant sum of all pressures that a system may be subjected to and withstand the same without causing any direct/ indirect damage and/ or breach in integrity and/ or its performance..

Diving Operations:

Surface oriented diving procedures to ensure consistent, efficient and safe diving and decompression performance. Procedures shall be based on IMCA (International Maritime Contractor Association) and/or other International Codes of Practice for Offshore Diving.

Environmental load

Loads caused by natural conditions that exists at the location other than the structural load and load due to inherent properties of the material under consideration.

External hydrostatic pressure

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Pressure acting on any external surface resulting from its submergence in water.

Flowlines

Subsea flowlines can be defined as subsea pipelines comprising either of the following:

- transporting oil and/or gas from satellite subsea wells to subsea manifolds.
- transporting oil and/or gas from subsea manifolds to production facility platforms.
- transporting water or chemicals from production facility platforms, through subsea injection manifolds to injection wellheads.

Functional load

Loads which are caused by physical existence and use of the facilities.

FPSO:

Floating Production Storage & Offloading is a floating vessel used for processing, storage & offloading of hydrocarbons.

FSO:

Floating Storage & Offloading is essentially a simplified FPSO without the capability of oil or gas processing.

Hot work:

It is an activity which involves welding, burning, soldering, brazing, chipping by spark producing tools, use of power driven tools, non-flame proof electrical work including other work which can produce sufficient energy to cause ignition where potential flammable mixture (mixture of flammable gas with an oxidizing agent) or a flammable substance exists.

Hyperbaric weld:

A weld performed at ambient hydrostatic pressure in a submerged chamber from which the water has been removed from the surfaces to be welded.

Land fall point:

Land fall point is where the pipeline enters into the land normally separated by Insulation Joint from offshore portion of the pipeline.

License

The entity or company to whom a petroleum exploration license is issued for the purpose of carrying out petroleum operation.

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Maximum Allowable Operating Pressure (MAOP)

The maximum pressure at which the pipeline is allowed to operate.

MSV/DSV: Multipurpose / Diving Support Vessel

Nominal Pipe Size

It indicates the standard pipe size when followed by a number.

Nominal Wall thickness

It is the nominal thickness of the pipe used in design calculation.

Offshore installation

A mobile or fixed installation (either on sea bed or above water) including any pipeline attached thereto, which is or is to be, or has been used, while standing or stationed in relevant waters with a view to explore or exploit or transport/transfer petroleum products, including crude oil and natural gas.

Operating Pressure

It is the pressure corresponding to a particular flow rate at which pipeline is operated. Operating pressure may be less than or equal to MAOP but never exceed MAOP.

Offshore Pipelines

Offshore pipelines are those pipelines which carry crude petroleum or its products or natural gas from producing sources, such as, well-head platforms, sub-sea wells/manifolds or between SPM system and main platform in the offshore and are transporting crude petroleum or its product or natural gas from main platform or Single point mooring system used for loading/unloading/handling of hydrocarbons to the place where facilities are available to receive them on land. Effluent/inlet water/ water injection line are also part of Offshore Pipelines.

Offshore

Areas beyond the line of ordinary high water, along that portion of the coast that is in direct contact with the open seas and beyond the line marking the seaward limit of inland coastal waters.

Pipeline System

This means subsea pipelines and risers transporting hydrocarbons and other commodities, with associated safety systems, valves, pig launchers or receivers, manifolds, corrosion protection system and other accessory / equipment.

Pipeline system limits are as follows:

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Up to and including the pig launcher/pig receiver on an installation
On a subsea installation the pipeline system shall end at the X-Mas tree.
The pipeline system ends at the first valve on shore approach.

Purging

It is the process of replacing the atmospheric air within a container (pipeline, vessels, filters etc.) by an inert substance in such a manner so as to prevent the formation of explosive mixture.

Risers

Means part of the pipeline system which extends from the subsea pipelines up to the installation including launchers or receivers.

Single Point Mooring (SPM) System

Single Point Mooring System is a terminal system for loading / unloading of crude petroleum and other petroleum products from/ to ocean going tankers within the environmental conditions existing at the installation area.

Specified Minimum Yield Strength (SMYS)

It is the minimum yield strength specified by specification or standard under which material is purchased from the manufacturer.

Splash Zone

The area of the pipeline riser or other pipeline components that is intermittently wet and dry due to wave and tidal condition.

Submerged Zone

That part of the pipeline system below the splash zone including buried parts.

Two / Multi Phase Flow

When flowing fluid is composed of gas and liquid in any proportion then it is known as two / multi-phase flow.

Weight Coating

Coating done on the pipeline for pipeline stability.

Shall

The word 'Shall' is used to indicate that the provision is mandatory.

Should

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The word 'Should' is used to indicate that the provision is recommendatory as sound engineering practice.

4.0 Regulations, Codes and Standards

The design of the SPM and pipeline system will in order of priority satisfy the requirements of the latest revisions of the relevant International Codes and Standards as listed below. If the Government or Local Authority Laws and Regulations are more stringent than the International Codes and Standards, the former will take precedence.

The relevant regulations, codes and standards are listed below:

4.1 Regulations

Offshore pipelines and its associated facilities are covered under various regulations and requires specific approval from concerned authorities. Various regulations applicable, but not limited to, are as follows:

(i) Environment Clearance including CRZ clearance under “The Environment (Protection) Act, 1986”, if applicable.
(ii) Clearance from National Hydrographic Office under Indian Navy Act, if applicable.
(iii) Navigational Safety of Port Committee under Ministry of Shipping, if applicable.
(v) Clearance for frequency allocation for HF, VHF, UHF and microwave system, if applicable.

In addition to above all other statutory approvals required for laying of the offshore pipeline and facilities shall be applicable.

4.2 Codes and Standards

Latest Version of following codes and standards shall be applicable but not limited to, as per requirement:

<table>
<thead>
<tr>
<th>REFERENCE DOCUMENT</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNV-OS-F101</td>
<td>Submarine Pipeline System</td>
</tr>
<tr>
<td>DNV-RP-B401</td>
<td>Recommended practice for cathodic protection design</td>
</tr>
<tr>
<td>DNV 1981</td>
<td>Rules for Submarine Pipeline Systems</td>
</tr>
<tr>
<td>DNV-RP E305/ F 109/</td>
<td>On-Bottom Stability Design of Submarine Pipelines</td>
</tr>
<tr>
<td>DNV RP F 105</td>
<td>Free Spanning Pipelines</td>
</tr>
<tr>
<td>DNV-RP-F110</td>
<td>Global Buckling of Submarine Pipelines</td>
</tr>
<tr>
<td>DNV RP F 116</td>
<td>Integrity Management of sub-marine pipelines</td>
</tr>
</tbody>
</table>

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5.0 Design of pipeline system:

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Design of offshore pipeline shall be in accordance with DNV 1981 (Rules for Submarine pipeline system) / DNV standard OS-F101. Onshore portion/ top side of Offshore pipelines shall be as per ASME B 31.4 or ASME B 31.8 as the case may be.

The pipeline system can be considered for abandonment after its stipulated design life is over. The life of pipeline can be extended beyond the design life subject to satisfying the comprehensive pipeline integrity assessment under the Petroleum & Natural Gas (Safety in Offshore Operation) Rule, 2008.

A design life of minimum 30 years for pipeline system and 5 years for flow lines shall be considered for designing various system and facilities beyond which pipeline system can be considered for abandonment. The life of pipeline can be extended beyond the design life subject to satisfying the comprehensive pipeline integrity assessment and accepted by Competent Authority under the Petroleum & Natural Gas Rule 2008 (Safety in Offshore Operation).

However, wherever life of field itself is lower than 30 Years, in that case life of pipeline system shall commensurate with field development plan.

5.1 Characterisation of fluids:

Fluids to be transported by the pipeline system shall be categorized according to their hazard potential as per the below table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Typical non-flammable water based fluids</td>
</tr>
<tr>
<td>B</td>
<td>Flammable and/or toxic substances which are liquids at ambient temperature and atmospheric pressure conditions.</td>
</tr>
<tr>
<td>C</td>
<td>Non-flammable substances which are non-toxic gases at ambient temperature &amp; pressure conditions.</td>
</tr>
<tr>
<td>D</td>
<td>Non-toxic, single-phase natural gas Flammable and/or toxic fluids which are gases at ambient temperature and atmospheric pressure conditions and which are conveyed as gases and/or liquids.</td>
</tr>
</tbody>
</table>

In case the fluid category is not clear, the most hazardous category shall be assumed.

5.2 Location Class

The pipeline system shall be classified into location class as per the below table:

<table>
<thead>
<tr>
<th>Location</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The area where no frequent human activity is anticipated along the pipeline route</td>
</tr>
<tr>
<td>2</td>
<td>The part of the pipeline/riser in the near platform (manned) area or in areas with frequent human activity. The extent of location Class 2 should be based on appropriate risk analyses. If no such analyses are performed a minimum distance of 500 m shall be adopted.</td>
</tr>
</tbody>
</table>

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5.3 Safety classes

The pipeline design shall be based on potential failure consequence. In this standard, this is implicit by the concept of safety class. The safety classes are defined as under:

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Where failure implies low risk of human injury and minor environmental and economic consequences.</td>
</tr>
<tr>
<td>Normal</td>
<td>For temporary conditions where failure implies risk of human injury, significant environmental pollution or very high economic or political consequences.</td>
</tr>
<tr>
<td>High</td>
<td>For operating conditions where failure implies high risk of human injury, significant environmental pollution or very high economic or political consequences. This is the usual classification during operation in location class 2.</td>
</tr>
</tbody>
</table>

5.4 SAFETY RISK ASSESSMENT:

A formal quantitative risk assessment (QRA) shall be carried out for pipeline connected to permanently manned offshore complexes, except for pipelines transporting category A fluids. The necessary riser protection and safety systems shall be derived from this assessment.

5.5 Loads:

Loads are classified as:

(a) Operational Loads.
(b) Environmental loads.
(c) Construction loads.
(d) Accidental Loads.
(e) Hydrodynamic loads.

Offshore pipeline and associated facilities including riser system shall be designed for the most critical combination of operation and design environmental loads acting simultaneously on the pipeline system. Wind, wave and current data shall be considered for minimum 10 years (marginal fields) / 100 years as per the relevant codes.

5.5.1 Operational loads:

Operational loads are forces imposed on the pipeline system under static environmental conditions i.e., excluding wind, waves, current and other dynamic loadings. These include:

(a) weight of unsupported span of pipe including weight of pipe, coating, anodes, marine growth and all attachments to pipe, absorbed water and transported contents.
(b) Internal pressure during operation.
(c) External hydrostatic pressure
(d) Temperature of content.

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(e) Cover  
(f) Pre-stressing  
(g) Static soil induced loading.  
(h) Load induced by frequent pigging operation.  
(i) Load induced by multiphase flow.  
(j) Temperature differential (between the material being transported & surrounding).  
(k) Thermal expansion & contraction.

5.5.2 Environmental loads:

Loading that shall be considered under this category includes:

(a) Waves  
(b) Current  
(c) Wind  
(d) Seismic events  
(e) Hydrodynamic loads caused by relative motion between pipe and water.  
(f) Dynamic soil induced loadings  
(g) Seasonal effect

5.5.3 Construction loads:

Loads which are caused by construction of the pipeline system, pressure testing, commissioning, maintenance and repair etc. shall be considered. Loads which shall be considered for pressure testing include:

(a) Weight of pipe, coating and their absorbed water and attachments to pipe.  
(b) Weight of water used for hydrotesting.  
(c) Buoyancy  
(d) Thermal expansion & contraction.

5.5.4 Accidental loads:

Loads which are imposed on pipelines due to abnormal and unplanned conditions such as dropped objects, vessel impact, dragging anchors, fire, explosion and other operating malfunctions etc.,

5.5.5 Hydrodynamic loads:

Loads caused by the relative motion between the pipe and surrounding water shall be considered while designing the pipeline system.

5.6 Pipeline strength:

Pipeline strength for Offshore pipelines shall be checked in accordance with DNV 1981 (Rules for Submarine pipeline system) / DNV standard OS-F101. Onshore portion/ top side of Offshore pipelines shall be checked as per ASME B 31.4 or ASME B 31.8 as the case may be.

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5.7 Pipe wall thickness:

Pipe wall thickness calculations shall be carried out as per clause 5.6 and a corrosion allowance as per the requirements of the owner of the pipeline shall be added to the calculated thickness. Pipe wall thickness shall not be less than 12 mm with nominal diameter 12.75" and above. The diameter to wall thickness ratio should not exceed 60, unless it can be demonstrated that higher values are not detrimental to the construction and in-situ integrity of the pipeline.

5.8 Corrosion allowance:

A corrosion allowance shall be provided in case the pipeline is proposed to carry potentially corrosive fluid and / or the pipeline is exposed to external corrosive environment. Pipelines and risers proposed to be laid in normal and high safety class areas, shall be provided with minimum 3 mm corrosion allowance in wall thickness.

5.9 Ovalisation:

Ovalisation in the pipe cross section with out of roundness tolerance from fabrication shall not exceed 2%. Ovalisation, $f_o$, shall be determined as follows:

$$f_o = \frac{(D_{\text{max}} - D_{\text{min}})}{D} = 0.02$$

Where,

$D_{\text{max}}$ = Maximum diameter
$D_{\text{min}}$ = Minimum diameter
$D$ = Nominal diameter

5.10 Pipeline route:

A detailed survey of the proposed pipeline route shall be carried out to gather sufficient data for design and installation of the pipeline. While carrying out pipeline route survey, following minimum consideration shall be taken into account:

(a) Soil parameters
(b) Seabed profile and bathymetry
(c) Existing submarine pipelines, power and communication cables.
(d) Ship traffic and anchorage area.
(e) Fishing activity.
(f) Unstable / uneven sea bed/ tidal behaviour
(g) Mining / archaeological activity
(h) Military exercise area
(i) Seismic zone.
(j) Offshore installation.
(k) Waste / ammunition dumping area
(l) Ship wreck

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At the land fall point/ inter-tidal zone special consideration shall be made for pipe route keeping in mind facility installation and minimum environmental impact.

5.10.1 Pipeline layout:

Pipeline route should avoid all identified hazards as far as practicable. Pipeline shall not be located close to other structures. The minimum distance should be determined based upon anticipated deflection due to hydrodynamic effects. The detailed routing shall take into account possible deflections movement and other risk to ensure a sufficient separation and margin against difference.

Notice to Mariner shall be promulgated by Indian Hydrographic Office through the conservancy of Port Authority or Maritime Board – During and Post construction.

5.10.2 Pipe Protection :

Pipeline shall be protected against any damage caused by e.g., dropped objects, ships, anchor etc., Protection may be achieved by one or a combination of following means:

i. Concrete Coating
ii. Burial
iii. Cover (sand)
iv. Other mechanical protection

5.10.3 Pipeline Corridor :

The pipeline shall be installed within 100 m of the selected pipeline route and shall not be installed outside the survey corridor. In the congested area no deviation from the selected pipeline route shall be allowed.

5.11 On-bottom stability :

On-bottom stability calculations are performed to establish requirements for pipeline submerged mass. The required pipeline submerged mass will have a direct impact on the required pipe lay tensions, installation stresses and the pipe configuration on the sea bottom. From the installation viewpoint, especially where spans are not a concern, the priority is to minimize the required pipeline submerged mass.

On-bottom stability calculations shall be performed for the operational phase and for the installation phase. The environment loading conditions to be considered as per the requirement of DNV 1981/ DNV RP F 109/ DNV RP E 305/ AGA Level 2. Generally, for Operation condition 100 year return period and for Installation condition one (1) year return period is to be considered.

The pipeline is filled with content at the expected lowest density when considering the operational phase.
The pipeline is assumed to be air filled for the on-bottom stability analysis when considering the installation phase. For the installation condition, a minimum specific gravity of 1.1 is required.

Pipeline shall be designed by considering following points.

Liquid or gas pipelines in the air or gas filled condition shall have a specific gravity which is higher than that of the surrounding sea water (negative buoyancy).

Buried pipeline shall have adequate safety against sinking. It shall be considered assuming that pipeline is water filled and floatation shall be considered assuming that the pipeline is gas or air filled.

Pipeline resting directly on the sea bottom without any special supporting structure other than weight coating shall be designed against sinking.

It shall be ensured and documented that pipeline situated on the sea bottom have adequate safety against being lifted off the bottom or moved horizontally.

The pipeline shall be supported, anchored in open trenches or buried in such a way that under extreme functional and environmental loading conditions, the pipeline will not move from its as installed position.

When the pipeline is routed in areas that are influenced by unstable slopes and are prone to slope failure and flow of soil that can impact the pipeline, appropriate safety measures shall be designed for safety of the pipeline.

Special considerations shall be made for parts of the pipeline system which extend onshore. These shall typically include aspects such as:

a. population density,
b. personnel
c. traffic
d. corrosion
e. Fracture arrest.
f. Sensitivity of the region
g. Intertidal zone

All main offshore pipeline system (excluding effluent/ treated water lines for disposal) shall be provided with pigging facility. Facilities shall be designed for carrying intelligent pigging.

Leak detection system should be provided in all main offshore pipelines (excluding effluent/ treated water lines). For details refer clause 11.0.

5.12 Insulation:

When the subsea pipeline is required to be thermally insulated due to operational necessity, it shall be ensured that the insulation is resistant to the combination of water, temperature and hydrostatic pressure.

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5.13 Environmental data:

Environmental data related to wind, wave, tide, difference in water density, marine growth, earthquake, current, Air/sea temperature etc. shall be collected for the last 10 years and used for the design basis.

Air and sea temperature statistics shall be obtained for the last 10 years. Minimum and Maximum design temperature shall be firmed up based on such data. Monitoring of temperature data shall be collected during construction, installation and commissioning and appropriate safety protection measures shall be taken if significant variation is observed with respect to design assumptions. Environmental Data for a 100 Year return period.

5.14 Surge analysis

Surge analysis shall be carried out for the entire system and necessary mitigation measures shall be taken as per the recommendations.

6.0 Design of risers:

Risers shall be routed, preferably, inside the jacket bracing lines in splash zone to provide a level of protection against vessel impact. In case of existing jacket riser shall be appropriately protected against vessel impact.

In case a number of small diameter riser lines are required to be installed together, same shall be done by installing the risers in a casing pipe with a pressure bulk head at either end. The access problem for external inspection may be overcome by filling the annulus with inhibited water or pressurised nitrogen.

Pipeline risers shall be designed considering safety risk assessment as stated in clause no. 5.4.

Detailed stress analysis under different inherent load conditions has to be done to establish the appropriateness of the riser and its anchor design.

Suitable Passive fire protection is to be considered in the exposed area of the risers.

7.0 INSPECTION:

The following are the various inspections that shall be carried out to ensure safe Operation of Offshore Pipelines/System.

7.1 FREE SPAN SURVEY:

Free span survey shall be performed as part of as-built survey followed by baseline survey within two years of commissioning. Subsequent frequency of Free Span Survey shall be increased based on the assessment of baseline survey. However, the
frequency shall not exceed 5 years. Operator has to ensure that the free span shall be within allowable limits as per Free Span Analysis.

7.2 **LATERAL DISPLACEMENT SURVEY:**

Lateral Displacement Survey shall be performed as part of as-built survey followed by base line survey within two years of commissioning. Subsequent frequency of Lateral Displacement Survey shall be increased based on the assessment of base line survey. However, the same shall not exceed 5 years. Operator has to ensure that the Lateral Displacement shall be within allowable limits as per the design code adopted.

7.3 **PIGGING OF PIPELINES :**

Pipelines transporting liquid hydrocarbon / gas/ water injection lines should be cleaned annually, or as per the frequency established by the Operator based on transported fluid properties. Pigging record shall be maintained. Pig residue collected after cleaning shall be examined for the presence of Fe, Fe₂O₃, Si, Sulphur, pH value, SRB, sulphates, carbonates etc., to monitor the condition of the pipeline and to determine the subsequent frequency of cleaning.

7.4 **INSPECTION OF SACRIFICAL ANODES:**

Random Sacrificial anodes representative of the pipeline system, shall be inspected once in 5 (five) years to establish the consumption pattern, wherever possible based on CPL survey..

7.5 **CONTINUOUS POTENTIAL (CPL) SURVEY :**

Continuous Potential Logging survey shall be done once in five years.

7.6 **EXTERNAL DEBRIS/ MARINE GROWTH CLEANING :**

Debris/ marine growth cleaning in the risers should be done once in five (5) years, if required.

7.7 **CHECKING OF LEAK DETECTION :**

A system should be in place for monitoring leak in shortest possible time & should be maintained in good working condition.

7.8 **INSPECTION OF VALVES :**

All Critical Valves shall be partially operated (PST-Partial Stroke Test) and inspected once in a year to ensure operability at all times.

7.9 **INSPECTION OF LOAD LIFTING EQUIPMENT :**

All load lifting equipment, wire ropes, tackles etc., shall be tested once in a year as applicable.

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7.10 INSPECTION OF TELECOMMUNICATION SYSTEM/ EQUIPMENT:

i) System functional tests shall be carried out fortnightly.

ii) Telecommunication equipment shall be inspected quarterly or as per manufacturer’s recommendations.

7.11 INSPECTION OF TELEMETRY SYSTEM/ EQUIPMENT:

i) System functional tests shall be carried out fortnightly.

ii) Telemetry equipment shall be inspected quarterly or as per manufacturer’s recommendations.

7.12 INSPECTION OF FIRE FIGHTING EQUIPMENT:

Inspection of Fire Fighting equipment shall be carried out as per OISD-STD-142.

7.13 INSPECTION OF SAFETY INSTRUMENTATION:

Maintenance and Inspection of Safety Instrumentation, shall be carried out as per OISD-STD-153.

7.14 INTELLIGENT PIGGING:

The pipeline shall be inspected once in 5 years for corrosion / dents / pits etc. by means of electronic / intelligent pigging. In case Intelligent pigging is not possible due to some reasons Internal Corrosion Direct Assessment (ICDA) shall be carried out once in five years by reputed third party agency as per NACE standard. The results of subsequent inspections shall be compared with original commissioning data in order to assess the health of the pipeline and subsequent periodicity of intelligent pigging/ ICDA.

After commissioning, baseline data to be collected by carrying out Intelligent Pigging Survey/ ICDA, as applicable.

Note: Offshore pipelines which will be commissioned after 1st Jan 2019 shall be designed for internal inspection by Instrumented Pigging.

7.15 WELD REPAIR AND INSPECTION:

All weld repair and inspection should be carried out in accordance with provisions of OISD-STD-141 and API 1104. API 1107, API 2200, API 2201, DNV OS F 101 shall be referred for guidance.

7.16 REPLACEMENT OF DEFECTIVE PIPELINES:

Pre-tested pipe shall be used for all replacements in line with the requirements of OISD-STD-141, OISD-STD-226, ANSI B.31.4, ANSI B.31.8 and API 1100.

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7.17 RISK BASED INSPECTION (RBI):

All pipeline assets which have crossed their designed life shall derive their inspection plans based on associated risks of failure. All associated threats to the pipeline assets should be taken in to consideration while evaluating Probability of Failure of the pipeline & consequences. DNV RP F 116 can be utilised for reference. A detailed five year road map towards risk reduction to be prepared based on risk ranking & implemented.

7.18 INSPECTION ITEMS OF SINGLE POINT MOORING SYSTEM :

The following are the various inspections that shall be carried out to ensure safe operation of Single Point Mooring System :

7.18.1 DAILY INSPECTION :

The following items shall be inspected daily during loading operation:

   i) Free floatation of buoys
   ii) Draft
   iii) Free movement of rotating assembly.

7.18.2 WEEKLY INSPECTION :

The following items shall be inspected weekly during loading operation:

   i) Mooring ropes and ancillary equipment (e.g. supporting buoys, anti chafe chains, wire ropes, hawser float, chain link on the turn table of buoys etc.) for any defect.
   ii) Batteries
   iii) Navigational aids

7.18.3 MONTHLY INSPECTION :

Visual inspection of buoys and equipment for external corrosion, shall be carried out once in a month.

7.18.4 QUARTERLY INSPECTION :

The following items shall be inspected quarterly as per OEM :

   i) Anchor chains of buoys.
   ii) Fenders for damage
   iii) Draft of buoys
   iv) Floating Hose
   v) Sub-sea hose configuration
   vi) Hose connection with respect to PLEM end & buoy end.
   vii) Sacrificial anodes
   viii) Swivel joints and turn table

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7.18.5 YEARLY INSPECTION:

The following items shall be inspected yearly/ as per OEM and in detail during dry docking:

i) Expansion joints
ii) Oil swivel seals
iii) Load lifting equipment

7.19 INSPECTION OF HOSE:

Inspection of hoses shall be carried out as per OISD-STD-135.

Detailed inspection of SPM shall be carried out in line with Annexure-II.

8.0 MAINTENANCE:

The principal function of maintenance is to ensure that physical assets continue to fulfil their intended purpose. The maintenance objectives with respect to any item or equipment should be defined by its functions and its associated standards of performance.

9.0 Repair:

The general guidelines for acceptable methodology to effectively repair the subsea pipeline leakages are as follows. The guidelines for this plan covers pipeline repair using equipment like clamps, connectors and purpose built devices to suit water depth, location, leak / rupture size & geometry etc., in the repair of subsea pipelines, risers and valves.

Latest Version of DNV RP F 113 (Pipeline Subsea Repair) or other recommended practices / applicable codes shall be followed for repair.

9.1 Conventional Repair Methods:

Damage to a submarine pipeline can be repaired in different ways depending on the water depth and on the type and extent of the damage. Various types of conventional methods are given below:

i. Non-critical repair work.
ii. Minor repair requiring the installation of a pinhole type repair clamp.
iii. Medium repair requiring the installation of a split sleeve type repair clamp.
iv. Major repair requiring the installation of a replacement spool.

Non-critical intervention work such as free span correction, retrofitting of anode and rock dumping, can usually be considered as planned preventive measures to reduce the risk of an emergency occurring.

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For the localized repair of non-leaking minor and intermediate pipeline damage, repair clamps are likely to be utilized and without the necessity of an emergency shutdown to the pipe line system.

For major pipe line damage resulting in, or likely to result in, product leakage, immediate production shut down and depressurization is invariably required allowing the damaged pipe section to be cut out and replaced by a spool using surface/hyperbaric welding techniques or mechanical connectors.

**Repair Methods vs Applicable Water Depths are given in the below Table.**

<table>
<thead>
<tr>
<th>Repair Method</th>
<th>Water Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-50m</td>
</tr>
<tr>
<td>Repair Clamp</td>
<td>✓</td>
</tr>
<tr>
<td>Hyperbaric Welding</td>
<td>✓ (Note b)</td>
</tr>
<tr>
<td>Mechanical Connectors</td>
<td>✓</td>
</tr>
<tr>
<td>Surface Welding</td>
<td>✓ (Note c)</td>
</tr>
</tbody>
</table>

**Notes:**

a. Technology exists for the diverless installation (by ROV) and the diverless installable hardware such as repair clamps and mechanical connectors.

b. Hyperbaric welding in water depths less than 20m is not practical and other repair solutions are required.

c. Water depth limitation for surface welding is governed by size of pipeline, weight of pipeline and vessel lifting capabilities.

9.2 Planned Maintenance:

Planned maintenance program include:

- Cathodic protection repair
- Span rectification procedures
- Installation of an engineered backfill (rock dumping)

10.0 Safety:

10.1 Safety on MSV: - All relevant personnel in operations involving hazardous substances should be made familiar with the specific hazards involved and the risk management options considered appropriate for the work. All diving operations are to be carried out in accordance with IMCA guidelines and all diving personnel associated with the repair operations shall be duly qualified in accordance with IMCA guidelines to carry out the diving operations.

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10.2 Worker Safety: - When repair operations are undertaken, an occupational health and safety program, including a site health and safety plan, should be available at site of operations. All personnel will be apprised of the site hazard, site safety practices and other provisions of the site health and safety plan.

10.3 Safety during diving near potentially contaminated locations (IMCA Guidance Note IMCA D 021)

Diver & their equipment can become contaminated by direct contact and or contamination of the diving bell atmosphere.

When diving in the vicinity of leaking pipelines where potentially hazardous substances may be present, a detailed analysis shall be carried out establishing the hazards involved and assessing the risks to be faced by the divers during the operation. Risk analysis shall be carried out and a safe operating procedure to be established.

When the leaking product is identified as having the potential to harm divers during the course of the operation, the task should be organized on the principle of ‘avoiding contact’.

Diving personnel should have appropriate PPE at their disposal as a contingency, in case of containment failure.

Depending on the product involved, it may be considered appropriate that suitable cleaning materials are carried in the Bell to enable cleaning of the helmet, suits, umbilical etc, so as to reduce the amount of contamination brought into the bell.

If the risk assessment identifies the need for over suits, disposable or washable, then these suits should be taken off before re-entering the bell.

10.4 Safety Precautions during Concrete and Bitumastic Removal:

Diver Responsibility: The diver shall be suitably trained in the operations of the required tools and shall be aware of the hazard involved with the same.

Superintendent Responsibility: The Diving Superintendent / Supervisor shall ensure that the diver, performing task at hand is adequately briefed and familiar with the requirements and limitations of the tools.

10.5 Spool Rigging and Launch Procedure:

At no point shall the diver be allowed to go under the load. All spool lifts on the deck of the vessel shall be done with the crane.

10.6 Safety Precautions during Spool, Shroud and Flange Underwater Cutting:

The following hazards have been identified for divers performing the work:

- Oxygen explosions
- Electrocution

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Oxygen Toxicity
Crush Injury (Heavy objects lifted by crane or falling)
Pinch Points (Hands/Arms etc.)

Following steps should be taken to eliminate or reduce risks:

**Oxygen Explosions:**

A detailed Risk analysis shall be carried out and actions to ensure safety during hot cutting operations be taken. In case it is considered safe after taking all the precautions, a vent hole shall be cut under any potential collection point. The diver will cut an escape window at 12o’clock position on the pipe before commencement of hot cutting.

**Electrocution:**

A DC electrical source is used to ignite the Broco torch each time the diver commences cutting. The diver and Superintendent must follow safe cutting procedures.

**Oxygen Toxicity:**

Depending upon the depth of work, the oxygen content is to be regulated to avoid oxygen related toxicity as per the related diving safety procedures/ manuals.

**Crush Injury:**

The concrete coated pipe lengths are quite heavy and pose a hazard both when cutting them, and when lifting them off bottom and clear of seabed. Other factors such as overhang and unknown site restrictions may also have to be taken into account.

The pipe shall be adequately supported and have a free span at the cut point where the final cut shall be at the top of the pipe, allowing the diver to be above and clear during this hazardous part of the cut.

**Pinch Points**

As the cut is being performed there is a potential hazard that the diver may get his fingers (or hand, umbilical, other equipment etc.) caught between the cut off ends or between the pipe and other fixed items on site. Both the diver and supervisor/ Superintendent must consider this before cutting commences so as to implement a plan to position the diver in a position where it does not occur. This must be particularly adhered to at the time the cut is about to be completed. The diver shall ensure that his umbilical is clear of the pipe during cutting operations.

**Caution shall be exercised during the approach of DSV/MSV to the location of a Gas pipeline leakage.**

10.7 **(Examination, testing & certification) - Diving Safety requirements of post commissioning of offshore facilities (maintenance).**

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Diving equipment, tools for under water use, under water lifting devices

- Saturation Chambers
- Diving Bell
- Diving Compressors
- Umbilical...etc.,

10.8 Safety (Diving Safety):

Company engaging in diving operations and or contracting/sub contracting/ part contracting diving activity should have a Quality, Health, Safety and Environment Policy.

Job specific risk assessment to be undertaken and findings to be incorporated in Standard Operating Procedure (SOP) ensuring safety of personnel and the risk is mitigated to lowest level. SOP to be approved by site-in-charge.

Tool Box talk to be given prior to undertaking an activity and record to be maintained for the same.

10.9 Plant and Equipment Certification:

Diving equipment shall be regularly examined and tested. IMCA Guidance Note IMCA D018 – Initial and periodic examination, testing and certification of diving plant and equipment should be followed.

Prior to undertaking a diving operation an inspection should be undertaken to verify correct certification and functioning of diving plant and equipment. This should be in accordance with IMCA Guidance Note IMCA D023 Design – Diving Equipment Systems inspection note for Surface oriented diving systems (Air). IMCA Guidance Note IMCA D 024 Design – Diving Equipment Systems inspection note for Saturation Diving Systems (Bell).

Copies of in-date certification shall be available and displayed. Any extension of certification should be in accordance with IMCA D 018; Section 7.5 – Extension of validity period.

10.10 Personnel:

Personnel engaged in direct/indirect and or support for dive related duties should meet relevant qualification, experience and medical fitness.

Divers should be qualified or have equivalent qualification as mentioned in IMCA D 014 – International Code of Practice for Offshore Diving.

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Duties and responsibilities of personnel undertaking a diving activity shall be clearly communicated and a record of the same should be maintained.

10.11 Operational Safety Requirements:

Safe working practices shall be those considered as minimum for operational safety. Reference should be made to IMCA D 022 The Diving Supervisor’s Manual

Roles and Responsibilities between diving and other personnel involved in the activity should be clearly defined

Task Hazard Identification, Risk Assessment and Control: All diving operations should be assessed for hazards by experienced senior diving personnel and appropriate controls shall be put in place

Emergency Procedures it is recognized that the Company would have in place a fully integrated Emergency Procedure

11.0 Pipeline leak detection:

Before a pipeline can be repaired, one of the most difficult tasks can be to locate its precise position, more so when it is a pin-hole leak. The relative difficulty of locating the pipeline is affected by factors such as the cause of the damage, the water depth, the product (oil, gas or water), and whether the pipeline is buried or exposed.

The damage can be classified as:

- Minor to intermediate damage, this form of damage can be due to either progressive deterioration (i.e. internal or external corrosion, scour below the pipe) or due to accidental effects (i.e. external impacts resulting in dents, gouges or even small leaks).

- Major damage, which involve substantial leakage from the system.

The damage location and assessment techniques are either external or internal.

In case of well fluid /gas lift lines leak location rough assessment can be made by locating the oil slick/gas bubbles at the sea surface with due consideration of sea tide and currents. Diver / ROV may be deployed to locate the leaking pipeline and leak location. At times, especially in case of leak from water injection line, injecting air/gas (pressure above the static head) may become necessary.

Visual techniques range from saturation diving to the use of manned submersibles and ROV’s (Remote Operated Vehicles). Saturation divers may visually locate the damage while walking the line. More often than not, the ROV may be used in conjunction with fluorimeters, sniffers or hydrophones.
Various leak detection technologies are available such as active acoustic methods, bio-sensor methods, capacitance method, fibre optic method, methane sniffer method, optical camera method, passive acoustic method, mass balance method.

12.0 Repair methodology:

An effective approach to a sub-sea pipeline repair operation requires consideration of the following concerns:

- Water Depth
- Pipe line dia, coating thickness and burial depth.
- Product the pipeline is carrying.
- Under water visibility/ current
- Type of pipeline failure and possible cause(s) of failure
- Condition of the pipe
- De-burial of the pipeline and removal of back filling, if any

Repair plan prepared should clearly define all the inputs required for carrying out the repair. The major inputs required are:

- Suitable Marine Spread with diving system
- Pipe line repair equipment and sub-sea tools
- Skilled manpower / diving team

The widely available equipment for repair are:

- **Split-Sleeve Clamps**: The simplest form of repair component is a metallic clamp, which may be applied/bolted to the pipe to cover a small defect to produce metal-to-metal and/or elastomer seal. Such clamps can be used for repair of pin-hole or small leaks.

- **Weldless connectors**: Weldless connectors / couplings are designed to provide weld less sub-sea connection of both ends of the pipeline (after removal of damaged / leaking segment) for carrying out spool piece replacement.

  The connectors consists of Connector/Coupling unit and may also have provision of Misalignment flanges.

- **Connector/ Coupling unit** - comprises of gripping mechanism to grip the pipe circumferentially & structurally attaches the connector to the pipeline, riser etc. and sealing mechanism for sealing with the outer surface of pipe for the joint integrity. It may also have telescopic adjustments to accommodate errors in subsea measurements and provide necessary movement to seat the ball in the misalignment flange.

- **Misalignment flanges** - to accommodate the angular adjustment up to $10^\circ$. This feature is quite useful for repairs where the pipeline is misaligned / damaged by anchor drag.

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• **Hyperbaric welding**: This method of welding is performed by diver/ welders in saturation who are sent down to habitat. The habitat is at the same pressure as the surrounding seawater and contains the types of tools required for welding.

13.0 **Testing of pipeline**:

After successful completion of repair the most reliable way to test a pipeline is with a hydrotest. However, the health of the pipeline may be reviewed based on available information on past leakages and repair history and line be hydro tested to operating pressure / high setting pressure of the line.

In some cases it may be possible to return the pipeline to service without hydrostatic testing. Such a case would be dependent on a combination of circumstances such as:

- The pipeline is new or has been recently hydrotested;
- The damage is known to be small and localized;
- The repair procedure did not disturb a significant portion of the pipeline;
- The normal line operating pressure is significantly lower than the design pressure.

The decision not to hydrostatically test the pipeline after a repair should only be considered if the delays incurred would be excessive in terms of loss of revenue. In such cases the operation of the pipeline shall be carefully monitored and the repair inspected by diver for a sufficient period after the repair operation.

14.0 **INCIDENT REPORT**:

The Operating Company shall file the incident investigation report to OISD and/or any such authority for an incident as soon as practicable but not more than 30 days after the incident. Liquid/Gas releases need not be reported if the spill was less than 5 MT, and did not result in significant water pollution.

15.0 **DOCUMENTATION**:

Formats for recording inspection findings shall be designed specifically for the equipment/ instrument/ system used in the Pipelines and SPM System.

The following data also shall be available on record in Pipeline installations:

i) The basic data and parameters of the Pipeline/ SPM System such as layout, length, diameter etc.

ii) A complete route strip map showing all the details of the passage of the pipeline and all isolating valve locations.

iii) List of various codes to which the Pipeline & SPM System have been designed.

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16.0 REFERENCES:

This standard shall be read in conjunction with the following standards, codes and publications:

i) API 1104 - Standard for Welding Pipelines and Related Facilities.

ii) API 1107 - Recommended Pipeline Maintenance Welding Practices.

iii) API 1109 - Recommended Practice for Marking Liquid Petroleum Pipeline Facilities.

iv) API 1110 - Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines.


vi) API 2200 - Repairs to Crude Oil, Liquefied Petroleum Gas & Products Pipelines.

vii) API 2201 - Procedures for Welding or Hot tapping on equipment containing Flammables.

viii) API 500C - Classification of Locations for Electrical Installations at Pipeline Transportation Facilities.

ix) NACE RP-01-69 - Recommended Practice - Control of External Corrosion on Underground or Submerged metallic Piping Systems.

x) ISO 15156 - Recommended Practice - Control of Internal Corrosion in Steel Pipelines Systems.

xi) NACE RP-06-75 - Recommended Practice - Control of Corrosion on Offshore Steel Pipelines.

xii) ASME - Boiler and Pressure Vessel code, Section VIII Division 1 Pressure Vessels, Section VIII 2 Alternate Rules for Pressure Vessels, and Section IX-Welding Qualifications.


xiv) ANSI-B-31.8-Gas and Distribution Piping System.


xvii) OISD-STD-142 - Inspection of Fire Fighting Equipment.

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xviii) OISD-STD-153 - Maintenance and Inspection of Safety Instrumentations.

xix) Factory’s Act
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## ANNEXURE-II

### INSPECTION SCHEDULES & PROCEDURES FOR SPM / AS PER OEM

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<th>Sr. No.</th>
<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PRE-BERTHING INSPECTION :</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Check the oil Spillage or leaks, whilst at the normal working conditions.</td>
<td>As &amp; when required at the time of berthing</td>
</tr>
<tr>
<td>2</td>
<td>Check that trim and freeboard of buoy are correct.</td>
<td>- Do -</td>
</tr>
<tr>
<td>3</td>
<td>Board buoy and check:</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Mooring connection.</td>
<td>- Do -</td>
</tr>
<tr>
<td>b)</td>
<td>Hatches.</td>
<td>- Do -</td>
</tr>
<tr>
<td>c)</td>
<td>For signs of damage to buoy.</td>
<td>- Do -</td>
</tr>
<tr>
<td>d)</td>
<td>Hose connection.</td>
<td>- Do -</td>
</tr>
<tr>
<td>e)</td>
<td>Pipework.</td>
<td>- Do -</td>
</tr>
<tr>
<td>f)</td>
<td>For signs of leakage from product swivel, rubber expansion pieces, or other piping components</td>
<td>- Do -</td>
</tr>
<tr>
<td>g)</td>
<td>That valves are operable and in the appropriate position.</td>
<td>- Do -</td>
</tr>
<tr>
<td>h)</td>
<td>Pressure gauge readings.</td>
<td>- Do -</td>
</tr>
<tr>
<td>i)</td>
<td>For unusual noise from bearing or product swivel, or loss of free movement.</td>
<td>- Do -</td>
</tr>
<tr>
<td>j)</td>
<td>Telemetry system.</td>
<td>- Do -</td>
</tr>
<tr>
<td>k)</td>
<td>Lights are functioning correctly.</td>
<td>- Do -</td>
</tr>
<tr>
<td>4</td>
<td>Inspect hawser and pick-up lines for damage and fouling.</td>
<td>As &amp; when required at the time of berthing</td>
</tr>
<tr>
<td>5</td>
<td>Inspect floating hoses along their length for damage, leakage and fouling whilst at the normal working conditions.</td>
<td>- Do -</td>
</tr>
<tr>
<td>6</td>
<td>Inspection of double carcass hose should be in accordance with the manufacturer’s guidelines.</td>
<td>- Do -</td>
</tr>
<tr>
<td>7</td>
<td>Check condition of the connections between the pick-up ropes and the chafing chains, the chafing chains, chain support buoys and connecting links, hose pick-up arrangements and tanker rail hoses should be checked. These checks should be performed by inspection from a launch prior to berthing, and subsequent visual checks</td>
<td>- Do -</td>
</tr>
<tr>
<td>8</td>
<td>WEEKLY CHECKS :</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Perform all checks in the pre-berthing inspection schedule.</td>
<td>Weekly</td>
</tr>
</tbody>
</table>

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<th>Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Board buoy and perform routine lubrication of:</td>
<td>Weekly</td>
</tr>
<tr>
<td>a)</td>
<td>Main bearing assembly.</td>
<td>Weekly</td>
</tr>
<tr>
<td>b)</td>
<td>Surface fluid swivel assembly.</td>
<td>Weekly</td>
</tr>
<tr>
<td>c)</td>
<td>Valve actuators.</td>
<td>Weekly</td>
</tr>
<tr>
<td>d)</td>
<td>Other auxiliary equipment.</td>
<td>Weekly</td>
</tr>
<tr>
<td>10</td>
<td>Sound buoy compartment for leakage/ water ingress.</td>
<td>Weekly</td>
</tr>
<tr>
<td>11</td>
<td>Check operation of bilge pump, if fitted.</td>
<td>Weekly</td>
</tr>
<tr>
<td>12</td>
<td>Check buoy fendering for damage. (D)</td>
<td>Weekly</td>
</tr>
<tr>
<td>13</td>
<td>Open bearing cavity drain plugs and monitor quantity of water, CALM ONLY</td>
<td>Weekly</td>
</tr>
<tr>
<td>14</td>
<td>Check condition and lubrication of bogey wheels system. (For CALM’S with bogey wheels only)</td>
<td>Weekly</td>
</tr>
<tr>
<td></td>
<td><strong>MONTHLY CHECKS:</strong></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Perform all checks in the weekly inspection schedule.</td>
<td>Monthly</td>
</tr>
<tr>
<td>16</td>
<td>Lift mooring equipment onto deck of maintenance boat and check:</td>
<td>Monthly</td>
</tr>
<tr>
<td>a)</td>
<td>Mooring hawser’s and hawser floats.</td>
<td>Monthly</td>
</tr>
<tr>
<td>b)</td>
<td>Chafing chain and check for wear.</td>
<td>Monthly</td>
</tr>
<tr>
<td>c)</td>
<td>Chain support buoy.</td>
<td>Monthly</td>
</tr>
<tr>
<td>d)</td>
<td>Hawser thimbles.</td>
<td>Monthly</td>
</tr>
<tr>
<td>e)</td>
<td>Connecting chains and shackles.</td>
<td>Monthly</td>
</tr>
<tr>
<td>f)</td>
<td>Pick-up ropes and connections.</td>
<td>Monthly</td>
</tr>
<tr>
<td>17</td>
<td>Lift tanker rail hose onto deck of maintenance boat, or alternatively, inspect by divers, and check:</td>
<td>Monthly</td>
</tr>
<tr>
<td>a)</td>
<td>Tanker rail hose</td>
<td>Monthly</td>
</tr>
<tr>
<td>b)</td>
<td>Hose pick-up arrangement.</td>
<td>Monthly</td>
</tr>
<tr>
<td>c)</td>
<td>Butterfly valves, if applicable.</td>
<td>Monthly</td>
</tr>
<tr>
<td>18</td>
<td><strong>Board buoy and perform the following tasks:</strong></td>
<td>Monthly</td>
</tr>
<tr>
<td>a)</td>
<td>Check operation of all valve actuators and valves. (D)</td>
<td>Monthly</td>
</tr>
<tr>
<td>b)</td>
<td>Check all electrical systems.</td>
<td>Monthly</td>
</tr>
<tr>
<td>c)</td>
<td>Check battery boxes are dry and that seals are in good condition. Check electrolyte level and charges or replace batteries as required.</td>
<td>Monthly</td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>19</td>
<td>Attach strop between turntable and launch, tend hoses and slowly rotate turntable assembly through 360 deg. and listen for bearing noise. Check for hard spots or sluggishness. CALM ONLY.</td>
<td>Monthly</td>
</tr>
<tr>
<td>20</td>
<td>Check that bearing protection system is intact on both sides of the bearing. CALM ONLY.</td>
<td>Monthly</td>
</tr>
<tr>
<td>21</td>
<td>Inspect submarine fluid swivel assembly for signs of leakage. SALM ONLY. (D)</td>
<td>Monthly</td>
</tr>
<tr>
<td>22</td>
<td>Inspect base universal joint for signs of wear and security. SALM ONLY. (D)</td>
<td>Monthly</td>
</tr>
<tr>
<td></td>
<td><strong>HALF-YEARLY CHECKS:</strong></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Perform all checks in the Monthly inspection schedule.</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>24</td>
<td>Perform an in-situ pressure test (1.5 times operating pressure or design pressure whichever is less). Refer OEM guidelines for Handling, Storage, Inspection and Testing of Hoses.</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>25</td>
<td>Repair minor damage to paint work according to OEM paint specifications.</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>26</td>
<td>Check anchor piles, or anchors, and anchor chain connections including joining shackles where accessible. CALM ONLY. (D)</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>27</td>
<td>Check submarine main swivel. For procedure see Section 5.3.1 SALM ONLY. (D)</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>28</td>
<td>Check surface piping and expansion joints.</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>29</td>
<td>Check anchor leg. SALM ONLY. (D)</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>30</td>
<td>Inspect condition of submerged portion of fenders. SALM ONLY (D).</td>
<td>Half Yearly</td>
</tr>
<tr>
<td>31</td>
<td>Inspect condition of flooding valve. SALM ONLY. (D)</td>
<td>Half Yearly</td>
</tr>
<tr>
<td></td>
<td><strong>YEARLY CHECKS:</strong></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Perform all checks in the half-yearly inspection schedule.</td>
<td>Yearly</td>
</tr>
<tr>
<td>33</td>
<td>Perform complete inspection of cathodic protection system. The anodes should be cleared to ensure that they provide maximum protection and anode should be replaced if 75% or more has been sacrificed.</td>
<td>Yearly</td>
</tr>
<tr>
<td>34</td>
<td>Remove sand and silt from mooring base and/ or PLEM. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>35</td>
<td>Inspect selected area of the hull for wall thickness.</td>
<td>Yearly</td>
</tr>
<tr>
<td>36</td>
<td>Inspect surface fluid swivel assembly and adjust bolts for tightness and record adjustments. CALM ONLY.</td>
<td>Yearly</td>
</tr>
<tr>
<td>37</td>
<td>Inspect inside of buoy compartments for corrosion and damage. Examine rubber manhole seals and replace as required.</td>
<td>Yearly</td>
</tr>
<tr>
<td>38</td>
<td>Check surface fluid swivel. CALM ONLY.</td>
<td>Yearly</td>
</tr>
</tbody>
</table>

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</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Clean marine growth from all anodes. Anode should be replaced if more than 75% consumed. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>40</td>
<td>Inspect perimeter of mooring base for signs of scouring of seabed, and anchor piles for signs of motion. Remove debris. SALM ONLY. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>41</td>
<td>Check surface fluid swivel drive plate for wear and distortion. CALM ONLY.</td>
<td>Yearly</td>
</tr>
<tr>
<td>42</td>
<td>Inspect selected area of the pipework for wall thickness. CALM ONLY.</td>
<td>Yearly</td>
</tr>
<tr>
<td>43</td>
<td>Check main turntable bearing. CALM ONLY.</td>
<td>Yearly</td>
</tr>
<tr>
<td>44</td>
<td>Check anchor chain and anchor or anchor piles. CALM ONLY. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>45</td>
<td>Check clearance between wheel and rails.</td>
<td>Yearly</td>
</tr>
<tr>
<td>46</td>
<td>Replacement of Mooring Hawser (100 vessels or 1 year in operation, whichever is earlier)</td>
<td>Yearly</td>
</tr>
<tr>
<td>47</td>
<td>Turntable bearing grease sample analysis for Iron content (&lt;25000 mg/Kg).</td>
<td>Yearly</td>
</tr>
<tr>
<td>48</td>
<td>Measure chain angles and chain wear down under buoy and adjust as required. CALM ONLY.</td>
<td>Yearly</td>
</tr>
<tr>
<td>49</td>
<td>Measure chain wear down at seabed. CALM ONLY. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>50</td>
<td>Replacement of chafe chains (any chain link diameter reduced to 90% of original diameter).</td>
<td>Yearly</td>
</tr>
<tr>
<td>51</td>
<td>Perform diver visual inspection of submarine hose string including floats, buoyancy tanks etc. Measure hose configuration and correct as required. (D)</td>
<td>Yearly</td>
</tr>
<tr>
<td>52</td>
<td>Replacement of Floating and submarine Hoses (OEM Guidelines)</td>
<td>OEM Recommendation</td>
</tr>
<tr>
<td>53</td>
<td>Measure axial wear down of Turntable bearing (&lt;1 mm).</td>
<td>Dry dock</td>
</tr>
<tr>
<td>54</td>
<td>Measure radial wear down of Turntable bearing (&lt;0.5 mm).</td>
<td>Dry dock</td>
</tr>
<tr>
<td>55</td>
<td>Anchor chain diameter wear down measurement (&lt;20%) upto touch down point.</td>
<td>Dry dock</td>
</tr>
<tr>
<td>56</td>
<td>Check surface fluid swivel oil seals and replaced as required. CALM ONLY.</td>
<td>Dry dock</td>
</tr>
<tr>
<td>57</td>
<td>Check PLEM. (D)</td>
<td>3 Yearly</td>
</tr>
<tr>
<td>58</td>
<td>Check anchor piles, where accessible.</td>
<td>5 Yearly</td>
</tr>
<tr>
<td>59</td>
<td>Dry-docking of SPM Buoy.</td>
<td>OEM Guidelines</td>
</tr>
</tbody>
</table>

Note: Items requiring divers are marked (D).

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# PART – 2: DESIGN, CONSTRUCTION, INSPECTION & MAINTENANCE REQUIREMENTS OF DEEP WATER PIPELINES

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Part-2: Deep Water Pipelines

1.0 INTRODUCTION:

Complete Deep Water production system ranges in complexity from single well with a flow line linked to fixed platform through different Deep Water hardware like manifold, pipeline end connection, jumper etc. As this installation is deep inside the water there should be a designed diver less system for it maintenance and inspection. So these things shall be taken care at the time of design stage and all provision shall be made available and accessible for monitoring and inspection.

2.0 SCOPE:

This document covers the minimum inspection requirement for offshore Deep Water pipelines used in the transportation of crude petroleum and natural gas along with minimum inspection requirements of accessories. Accessories shall include corrosion protection system, sand detection system, ROV access valve operation, subsea markings, well interventions facilities, subsea control system and connectivity through Umbilicals, hydrate prevention system and remediation system etc. It also demands additions studies like Flow Assurance, Dropped object study, Lateral buckling of pipelines, Deep Water hardware requiring suction anchor so toppling of those structure in various load scenario need to studied.

3.0 DEFINITIONS:

I) Deep Water Pipelines

Deep Water pipelines are those pipelines which carry crude petroleum or its products or natural gas from producing sources, such as, sub sea XMT to the Platform via different structures and are located at depth more than 400 meter.

II) Deep Water Structure

Deep Water Structures are the assembly to connect flow lines, Control umbilicals; Hydraulic lines etc., and are located at water depth more than 400 meter.

III) Remote Operated Vehicle (ROV)

A Remotely Operated Vehicle (ROV) is essentially an underwater robot that allows the vehicle's operator to remain in a comfortable environment while the ROV works in the hazardous environment below. The total ROV system is comprised of the vehicle, which is connected to the control van and the operators on the surface by an umbilical cable, a handling system to control the cable dynamics, a launch system and associated power supplies.

IV) Umbilicals

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Connections between topside equipment and sub sea equipment, the number and type of umbilicals vary according to field requirements, and umbilicals may carry the service lines, hydraulic tubes and electric cables and/or fibre-optic lines.

V) Jumpers/Tie – in spools

Connections for various sub sea equipment, including tie-ins between trees, manifolds or flow line skids.

VI) Pipeline system

- An interconnected system of submarine pipeline risers, supports, isolation valves all integrated piping component, associated safety system and Corrosion protection system. Pipeline system limits are as follows
- Up to and including the pig launcher/pig receiver on an installation
- On a subsea installation the pipeline system normally ends at the X-Mas tree
- The pipeline system ends at the first flange valve on shore approach.

VII) Hydrate

Natural gas hydrates are a solid form of water, composed of a lattice of water molecules stabilized by “guest” gas molecules occupying key positions in the crystal structure.

VIII) Hydrate Remediation

The phenomena of disassociating the hydrate is called hydrate Remediation.

IX) SHALL

The word 'Shall' is used to indicate that the provision is mandatory.

X) SHOULD

The word 'Should' is used to indicate that the provision is recommendatory as sound engineering practice.

4.0 Design:

Following issues shall be considered during the design stage of any Deep Water piping/system apart from the points mentioned in part – 1.

4.1 Sub sea Condition:

- Temperature: - ambient temperature is less so the fluid inside the system shall not be ceased under the low temperature condition so the proper chemical injection or cold insulation shall be considered as design stage.
- Soil Strata: - Sub sea soil study shall be carried out while designing the structures and self penetration/yearly soil deposition shall be considered at the design stage.
- Strom Design life: 100 years Met-Ocean data should be considered for the design of deepwater field development.
4.2 Flow Assurance:

Flow assurance study shall be carried out.

4.3 Dropped Object Studies:

- A minimum distance should be maintained between pipeline determined based upon anticipated deflection hydrodynamic effects.
- The detail routing shall take into account possible deflections movement and other risk to ensure a sufficient separation and margin against difference.
- Structure should be protected against unacceptable damage caused by e.g. dropped objects, ships, anchor etc.

4.4 Vent System:

- Vent system should be considered so that the Deep Water structure can be vented as and when required.
- During hydrate remediation care should be take that vent network is efficient for venting and also hydrate remediator can be injected as and when required.

4.5 Maintenance:

The critical equipment should be designed to facilitate retrieval & installation using ROV. Remotely Operated intervention system shall be possible for both of the following category:
1. Swimming vehicles (ROV)
2. Surface – run tooling.

Intervention systems shall be operated by ROV and are typically used for:
   a) Inspection;
   b) Operation of Valves;
   c) Injection or Sampling of Fluids;
   d) Installation and recovery of equipment;
   e) Connection of sub sea Line.

4.6 Sub sea controls:

There shall be control system characterised by cost-effective and high – reliability for simple tasks. For more complex scenario like well assembly to manifold and then manifold to another hardware these control system to be cost-effective they shall be installed sub sea and controlled at the top facility. This kind of system may use Electrical and Hydraulic signal as required.

This kind of control system typically called Electro hydraulic multiplexed systems consist of following:

a) The Hydraulic Power Unit (HPU);
b) Electrical Power Unit;
c) Control umbilicals;
d) Control modules and base plates
e) Interface with work over control system

4.7 Instrumentation:
Provision for measurement/monitoring of following should be given:

a) Flow  
b) Sand  
c) Internal Corrosion  
d) Temperature  
e) Pressure  
f) Hydrocarbon leak

4.8 Redundancy:

Maximum possible redundancy to be incorporated in the system for reliability and availability.

4.9 Material Selection and Wall Thickness Design

Materials selected shall satisfy requirements to strength, corrosion and fracture toughness as well as requirements to weldability. Harsher environments will often be present at deeper waters, and loads affecting the pipelines will in many cases be more severe than for shallower waters. High temperatures and pressures of the transported fluids, along with aggressive chemistry, are factors requiring a special consideration for internal and external pipe materials. Stresses arising from temperature changes are often somewhat higher for deep water pipelines, due to low temperatures at the seabed and high internal temperatures. Higher stresses and strains affecting the pipes during the installation processes will also have an influence on the material selection.

Applying higher graded steels in pipeline design will reduce the required wall thickness due to higher yield strength, which in order will decrease the weight, making pipelaying in deep water more feasible.

5.0 Planning:

Planning for maintenance should begin during the design of Deep Water systems and hardware. Potential maintenance tasks should be identified, optional approaches evaluated, and selections made for maintenance provisions to be incorporated into Deep Water systems and hardware. In some cases, simple and basic maintenance methods (i.e. wet divers with hand tools) may be warranted, while in other applications remote diver less tool may be necessary. For pipeline operation inspection maintenance and repair shall be prepared prior to start of operation. Apart from this requirement all the requirement stated in part 1 shall be applicable.

5.1 Inspection & Testing:

A quality plan shall be prepared and validated. The quality plan shall define the method and frequency for inspection testing calibrations acceptance criteria and requirements to documentation. Reference shall be made to applicable specification and procedure for inspection, testing and calibration.

5.2 Inspection Items of XMT:
The following are the various inspections required to ensure integrity & safe operation of Deep Water Pipelines/System.

5.2.1 XMT Inspection

Visual Inspection should be carried out annually.

5.2.2 Flow line & End Connection Inspection

Visual Inspection shall be carried out annually.

5.2.3 Inspection Of Sub sea Markings

All Deep Water structure is marked with Sub Sea marking and they should be checked annually. The sub sea marking is designed for the full design life period, the deposition of dust and debris shall be cleaned during the annual inspection of Sub Sea marking.

5.2.4 Inspection and Calibration of Sand Detector

Inspection & Calibration of Sand Detector shall be inspected once in 6 month remotely.

5.2.5 Inspection and Calibration of Chemical Injection Valve

Inspection & Calibration of Chemical Injection valve shall be done once in 6 month remotely.

5.2.6 Inspection and Calibration of Hydrocarbon Leak Detector

Inspection of Hydrocarbon Leak Detector shall be done once in five years.

5.2.7 Inspection and Calibration of Pressure/Temperature Transmitter

Inspection & Calibration of Pressure/Temperature transmitter shall be checked once in 6 month remotely.

5.2.8 Inspection and Calibration of Flow meter

Inspection & Calibration of Flow Meter shall be checked once in 6 month remotely.

5.2.9 Inspection Of ROV and Tools

ROV and tooling shall be inspected annually and when ever required as per need basis. Ensure availability.

5.2.10 Inspection of Electrical jumpers and its connectivity

I. System functional tests shall be carried out on need basis.
II. Electrical Jumper shall be inspected as per manufacturer's recommendation.
5.3 Pipelines & Flow lines :

5.3.1 Internal Condition Monitoring :

I. Internal inspection devices focus primarily on examining/recording the condition of the pipe using a variety of instruments mounted on pipeline pigs.

II. It is good practice to conduct a base line survey during construction as a reference datum for all subsequent surveys. A typical inspection programme is shown below:

A. Typical Inspection methods and corresponding inspection frequency

<table>
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<tr>
<th>In-line Inspection</th>
<th>Inspection Frequency</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Pipeline sizing/mapping by calliper/gyro pig or external survey</td>
<td>Start-up (baseline)</td>
<td>Frequency to be kept under review by risk/trend analyses</td>
</tr>
<tr>
<td></td>
<td>Two years after start-up then every 2 years</td>
<td></td>
</tr>
<tr>
<td>Magnetic flux leakage 'Intelligent' pig</td>
<td>Every ten years</td>
<td>Frequency to be kept under review by risk / trend analyses of integrity. No coupling medium required, runs in dry gas.</td>
</tr>
<tr>
<td>Crack detection intelligent pig</td>
<td>Consider use if cracking suspected</td>
<td></td>
</tr>
</tbody>
</table>

Internal condition Status can also be achieved through ICDA (Internal Corrosion Direct Assessment) as per required frequency typically not less than 5 years after establishing baseline through a reputed third party agency as per NACE standard

As it is not always possible that all fittings in the Deep Water Structures are piggable, but all components in Contractor’s scope, where practicable, will be designed to suit piggability, notably:

I. 5D Bends
II. Avoidance of back-to-back bends
III. All in-line valves full bore
IV. All branch fittings to be of small bore or to be barred if required, (NB Tees on small diameter lines will not be barred, since at this diameter there is little risk of intelligent pig hang-up, it should be noted the tee branch connections will not be piggable.)

5.3.2 External Condition Monitoring :

External inspections comprise of acoustic and visual imaging from an ROV from which the presence of external damage, debris or free spans can be observed. Deep Water Pipeline inspection methods and typical inspection frequencies are presented in the following tables covering external inspection, using deepwater Remotely Operated Vehicle (ROV) based systems.
<table>
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<th>External visual Survey by</th>
<th>Start-up (baseline)</th>
<th>As-built survey.</th>
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<tr>
<td>ROV (includes CP survey)</td>
<td>One year after start-up then every 2 years thereafter</td>
<td>Combining this ROV-survey with bi-yearly mapping by the gyro-pig, an annual survey of displacements is achieved.</td>
</tr>
<tr>
<td>Shore approach survey (&lt; 30 m) by small ROV or diver held camera</td>
<td>Start-up (baseline) Every year for the first 5 years then every two years thereafter</td>
<td>As built survey Also reinstatement monitoring</td>
</tr>
<tr>
<td>On-shore inspection from shore to terminals by visual observation and CP-measurements</td>
<td>Start-up Bi monthly observation. Bi-annual leak detection</td>
<td>Also reinstatement monitoring</td>
</tr>
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- The frequency and type of inspections may be varied after review of any trends in inspection results. Such a risk based approach to inspection activities can optimize costs for these programs (and any resultant maintenance activities) over the operating life of the pipeline system.
- If there is concern that damage to the pipeline may have occurred through some external event such as a large earthquake, tsunami, or a ship sinking, extraordinary inspection may be required.
- Engineering assessments are based on the results of the pipeline integrity inspection, minor damage or possible problems noted during inspections are subjected to engineering risk assessment to carefully evaluate the need for maintenance intervention.

5.4 Umbilicals :

5.4.1 Internal Condition Monitoring :

I. Internal condition monitoring of umbilicals is effectively a self-checking exercise. Any loss of performance should be immediately detectable by loss of signal, hydraulic pressure, etc.

5.4.2 External Condition Monitoring :

I. External inspection of umbilicals can be performed as part of the pipeline survey scope as defined above.

5.5 Deep Water Structures :

5.5.1 Internal Condition Monitoring :

I. Internal condition monitoring of Deep Water structures cannot easily be achieved in-place, due to their complexity and inaccessibility.
II. End connection and structures can only be internally monitored.

III. Sub Sea Isolation valves should be subject to regular testing. Full closure tests would increase risk of ball/seat wear and would disrupt production; therefore a programme of partial closure testing should be undertaken.

### 5.5.2 External Condition Monitoring:

I. Deep Water structures should be subject to regular visual and CP surveys.
II. ROV’s to enter the structure envelope if possible.
III. End Connection structure such as PLET/PLEM should be checked for displacement.

### 5.6 Sub Sea Control Structure:

a. Sub sea control structures should be subject to regular checks half yearly. Control Structures should be designed to be accessible and whole components should be retrieve with the need for ROV’s to enter the structure envelope if possible.

b. All Hydraulic supply going to the control module shall be confirmed for the safe disposal or return of hydraulic fluid along with its cleanliness inside the tubing or structure.

c. Hydraulic Fluid cleanliness will be checked every 15 days and whenever topping of fluid is there, whichever is earlier.

### 6.0 Inspection & Monitoring

Minimum following typical types of maintenance activity may call for as a result of routine inspections:
- Removal of debris from the pipe, umbilicals or structures or its vicinity with assistance of work class ROV, or divers in shallow water;
- Infill of free spans;
- Restoration of near shore protection;
- Placement and connection of additional anode to supplement worn out pipeline anodes;
- Structure maintenance.

All potential repair operations should be identified in Operations Manuals at least at a high level and subject to Risk Assessment and HAZID.

#### 6.1 Debris Removal:

Depending on the location and severity, debris can either be removed by ROV (dependent on the capabilities of the ROV spread used for survey, this could be done within the inspection program).

#### 6.2 Infill of Free spans:

Notifiable free span criteria for all pipelines, flow lines should be determined in detailed design. Where rectification is required, the method of rectification should take into consideration the following:

- Risk to deep Water Structure
- The urgency of rectification
- Equipment availability (Vessels, deployment systems etc.)
Local conditions (environment, risk of scour)
This ‘instability’ would only occur under 100 year conditions, so short term exposure in itself is not an immediate hazard to the pipeline. Rectification measures should be implemented by infilling.

6.3 Restoration of near shore protection:

The pipelines and umbilicals are trenched and buried to a certain depth. It is recommended that, particularly in the initial phase of operation, additional ‘trend’ surveys are undertaken, in particular to provide assurance that the selected rock dump berms remain stable and nucleate backfill, rather than additional scour. The operator should recognise the need to engage follow-on ad-hoc specialist support to assess any unexpected bathymetric changes. In the event pipelines become exposed, the following pipeline sections could in theory be exposed to short term instability.

6.4 Placement and connection of additional anode beds:

All components of the system shall be fitted with CP systems designed for the full lifetime of the facilities. In the event that excessive anode consumption trends are observed in regular surveys, additional anode beds could be fitted.

6.5 Structure Maintenance:

No operational maintenance is expected for structure. Where pipeline walking is observed through structure movement, an evaluation of spool loads should be conducted to verify design limit states have not been exceeded. As a contingency, it should be possible to isolate and replace the spool.

6.6 Pipelines, Flow lines:

Intrusive repair works will involve shutdown and isolation of a pipeline and replacement of a section.

In the event of damage requiring replacement of a pipeline section, it may be lower risk and more economical to simply install a replacement line, especially for the infield infrastructure.

Non-intrusive repairs may consist of coating damage repair and/or local reinforcement in the event of denting.

6.7 Umbilicals:

Spare length of umbilicals which should be held in storage and maintained. Repair work would involve excavation of the sufficient length to allow for surface pick-up and recovery.

6.8 Jumpers/Tie-in Spools

Any repair associated with spools other than non-intrusive coating repairs, would simply involve jumper/spool recovery and replacement. All spools can be isolated by closing valves on Deep Water Structures.

7.0 DOCUMENTATION:
Formats for recording inspection findings shall be designed specifically for the equipment/instrument/system used in the Deep Water Pipelines/Structure

The following data also shall be available on record in Pipeline/Structure installations

- The basic data and parameters of the Deep Water System such as layout, length, diameter etc.
- A complete route strip map showing all the details of the passage of the pipeline and all isolating valve locations.
- List of various codes to which the Pipeline & Deep Water System have been designed.

8.0 REFERENCES:

This standard shall be read in conjunction with the following standards, codes and publications:

i) DNV RPF 103 Cathodic protection of submarine pipelines.

ii) DNV RP F105 Free spanning of pipelines

iii) ISO 13628 -1/9 Design and operation of subsea production systems.

iv) NACE RP 01-75 Control of internal corrosion in steel pipeline and piping system.

v) DNVRP F107 Risk assessment of pipeline protection.