DESIGN, CONSTRUCTION AND INSPECTION REQUIREMENTS
FOR
CROSS COUNTRY LIQUID HYDROCARBON PIPELINES

OISD-STD-141
First Edition, April'1990
Amended Edition, September'2001
Revised Edition, September'2003
Complete Revision Edition, July 2012

Oil Industry Safety Directorate
Government of India
Ministry of Petroleum & Natural Gas
8th Floor, OIDB Bhavan, Plot No. 2, Sector – 73, Noida – 201301 (U.P.)
Website: www.oisd.gov.in
Tele: 0120-2593800, Fax: 0120-2593802
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 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 25 years 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

Pipeline systems are the safer & environment friendly mode of transportation of Crude and petroleum products as compared to other modes (rail /road etc). Being a closed system, handling and transit loss are minimum hence pipeline is considered as most efficient mode of transportation. Cross country pipelines has been playing a vital role in maintaining & ensuring supply of petroleum products across the country and fueling the energy growth. Nevertheless there are hazards associated with transportation of hydrocarbon through pipelines from accidental leaks, spills, & fires etc. Cross country pipelines which carries the hydrocarbon beyond the boundary of any facility therefore, need to follow dedicated corridor to facilitate its construction, laying, maintenance, inspection and testing etc in order to keep it away from public dwellings and protect the public & facilities against the hazard associated with transportation through pipelines. Special Safety protections are incorporated whenever the pipeline crosses the roads, railway lines, rivers, water bodies and bridges etc.

This standard was first published in April’1990 and was subsequently amended in the years 2001 and 2003 with the progressive accumulation of knowledge & experiences of OISD and Industry members in this field coupled with recommendations from incident analysis to incorporate preventive inbuilt design and health integrity practices in the standard.

Recent experiences of major fire incident and in-depth analysis & recommendations to cover all aspects like design, construction, maintenance, inspection and testing of pipeline in a single comprehensive standard called for complete revision of this standard in this July’2012 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 standard is meant to be used as a supplement and not as a replacement for existing codes & practices. The provision of this standard if implemented objectively will go a long way to improve the safety & reduce accidents in the Oil & Gas Industry. Users are cautioned that no standard can be a substitute for the judgment of responsible & experienced engineer. Suggestions are invited from the users after it is put into practice to improve the standard further. Suggestions for amendments to this standard should be addressed to :

The Coordinator
Committee on “Design, Construction & Inspection of Pipelines”
Oil Industry Safety Directorate.
OIDB Bhawan,8th Floor, Plot-2, Sector-73 Noida,UP-201301
Note: This standard in no way supersedes the statutory regulations of Petroleum & Explosive Safety Organization(PESO), Factory Inspectorate or any other Statutory Body which must be followed as applicable.
NOTE

OISD publications are prepared for use in the oil and gas industry under Ministry of Petroleum & Natural Gas. These are the property of Ministry of Petroleum & Chemicals and shall not be reproduced or copied and loaned or exhibited to others without written consent from OISD.

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 their prevailing statutory requirements.
FUNCTIONAL COMMITTEE MEMBERS
ON
DESIGN, CONSTRUCTION AND INSPECTION REQUIREMENTS
FOR
CROSS COUNTRY LIQUID HYDROCARBON PIPELINES
(COMPLETE REVISION JULY’2012)

<table>
<thead>
<tr>
<th>Name</th>
<th>Designation &amp; Organisation</th>
<th>Position in Committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sh. U. K. Pal</td>
<td>DGM (PJ-CIVIL), IOCL-PL</td>
<td>Leader</td>
</tr>
<tr>
<td>2. Sh. Vinay Mittal</td>
<td>DGM (HoD)-Pipeline, EIL</td>
<td>Member</td>
</tr>
<tr>
<td>3. Sh D.K. Banerjee</td>
<td>DGM (PJ- Gas), IOCL-PL</td>
<td>Member</td>
</tr>
<tr>
<td>4. Sh. Ashok Singh</td>
<td>AGM (Process), EIL</td>
<td>Member</td>
</tr>
<tr>
<td>5. Sh. L. R. Jain</td>
<td>Chief Manager, BPCL</td>
<td>Member</td>
</tr>
<tr>
<td>6. Sh. A.K. Jain</td>
<td>Chief Manager, HPCL</td>
<td>Member</td>
</tr>
<tr>
<td>7. Sh. A.K. Mishra</td>
<td>Chief Engineer(C&amp;M), OES, ONGC</td>
<td>Member</td>
</tr>
<tr>
<td>8. Sh. Pallab Nag</td>
<td>Dy. Chief Engineer (Pipeline), OIL</td>
<td>Member</td>
</tr>
<tr>
<td>9. Sh. S.K. Nandy</td>
<td>Additional Director (Engg.), OISD</td>
<td>Co-Ordinator</td>
</tr>
</tbody>
</table>

In addition to the above, several other experts from the industry contributed in the preparation, review and finalisation of this document.
ON
DESIGN AND INSPECTION OF PIPELINES
( First Edition April 1990 )

Name  Organisation

Leader
1. Sh.V.T. Karode    Oil India Limited
2. Sh.R.A. Shanbhag **  Indian Oil Corporation Limited

Members
3. Sh.Rao Rudravajala  Indian Oil Corporation Limited
4. Sh.S.K. Goyal    Oil and Natural Gas Corporation Limited
5. Sh.C.N. Char    Oil and Natural Gas Corporation Limited
6. Sh.E.M Bhumgara  Hindustan Petroleum Corporation Limited
7. Sh.R.K. Mulla     Hindustan Petroleum Corporation Limited
8. Sh.R.K. Dhadda  Engineers India Limited
9. Sh.G.V.S. Saiprasad  Gas Authority of India Limited
10. Sh.K.K. Dutta  Oil India Limited
11. Sh.R.K. Baruah  Oil India Limited

Member Coordinator
12. Sh.M. Bhandari  Oil Industry Safety Directorate

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).
COMMITTEE ON
DESIGN AND INSPECTION OF PIPELINES
(First Revision September 2003)

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader</td>
<td></td>
</tr>
<tr>
<td>1. Sh.A. Sengupta</td>
<td>Indian Oil Corporation Limited</td>
</tr>
<tr>
<td>Members</td>
<td></td>
</tr>
<tr>
<td>2. Sh.G.S. Wankhede</td>
<td>Bharat Petroleum Corporation Limited</td>
</tr>
<tr>
<td>3. Sh.KBS Negi</td>
<td>Bharat Petroleum Corporation Limited</td>
</tr>
<tr>
<td>4. Sh.S.S.Patel</td>
<td>GAIL India Limited</td>
</tr>
<tr>
<td>5. Sh.P.K.Pal</td>
<td>Indian Oil Corporation Limited</td>
</tr>
<tr>
<td>6. Sh.C.K. Soman</td>
<td>Kochi Refineries Limited</td>
</tr>
<tr>
<td>Member Coordinator</td>
<td></td>
</tr>
<tr>
<td>7. Sh.R.N.Mittal</td>
<td>Oil Industry Safety Directorate</td>
</tr>
</tbody>
</table>

In addition to the above, several other experts from the industry contributed in the preparation, review and finalisation of this document.
## DESIGN, CONSTRUCTION AND INSPECTION REQUIREMENTS FOR CROSS COUNTRY LIQUID HYDROCARBON PIPELINES

### CONTENTS

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>ITEM DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2.0</td>
<td>SCOPE</td>
<td>1</td>
</tr>
<tr>
<td>3.0</td>
<td>DEFINITIONS</td>
<td>1</td>
</tr>
<tr>
<td>4.0</td>
<td>STATUTORY ACTS AND REGULATIONS</td>
<td>5</td>
</tr>
<tr>
<td>5.0</td>
<td>DESIGN</td>
<td>6</td>
</tr>
<tr>
<td>6.0</td>
<td>SAFETY INSTRUMENTED SYSTEM</td>
<td>17</td>
</tr>
<tr>
<td>7.0</td>
<td>COMMUNICATION</td>
<td>19</td>
</tr>
<tr>
<td>8.0</td>
<td>PUMP STATION</td>
<td>19</td>
</tr>
<tr>
<td>9.0</td>
<td>MATERIALS</td>
<td>22</td>
</tr>
<tr>
<td>10.0</td>
<td>CORROSION CONTROL</td>
<td>24</td>
</tr>
<tr>
<td>11.0</td>
<td>CONSTRUCTION</td>
<td>28</td>
</tr>
<tr>
<td>12.0</td>
<td>TESTING AND COMMISSIONING</td>
<td>36</td>
</tr>
<tr>
<td>13.0</td>
<td>SAFETY AND FIRE PROTECTION SYSTEM</td>
<td>38</td>
</tr>
<tr>
<td>14.0</td>
<td>OPERATION AND MAINTENANCE</td>
<td>44</td>
</tr>
<tr>
<td>15.0</td>
<td>MANAGEMENT OF CHANGE</td>
<td>48</td>
</tr>
<tr>
<td>16.0</td>
<td>DEFECT DETECTION, ASSESSMENT AND MITIGATION</td>
<td>48</td>
</tr>
<tr>
<td>17.0</td>
<td>PIPELINE INTEGRITY MANAGEMENT</td>
<td>49</td>
</tr>
<tr>
<td>18.0</td>
<td>PIPELINE REPAIR</td>
<td>49</td>
</tr>
<tr>
<td>19.0</td>
<td>STATIC LEAK TEST</td>
<td>51</td>
</tr>
<tr>
<td>20.0</td>
<td>ABANDONMENT OF PIPELINE</td>
<td>51</td>
</tr>
<tr>
<td>21.0</td>
<td>DOCUMENTATION FOR OPERATION AND MAINTENANCE</td>
<td>51</td>
</tr>
<tr>
<td>22.0</td>
<td>AUDITS</td>
<td>51</td>
</tr>
<tr>
<td>23.0</td>
<td>REFERENCES</td>
<td>52</td>
</tr>
<tr>
<td>24.0</td>
<td>ANNEXURE</td>
<td>54 - 65</td>
</tr>
</tbody>
</table>
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 they are periodically inspected and maintained.

The primary purpose of this standard is to establish minimum requirement for design, corrosion protection, material, construction, inspection during construction, testing, commissioning, operation, maintenance, modification, abandonment and safety of cross country liquid hydrocarbon pipelines (steel) and also for protection of employees, public and facilities against the hazard associated with transportation of liquid hydrocarbon through pipelines.

2.0 SCOPE

2.1 This standard shall cover minimum requirements for pipeline design, corrosion control, materials, equipment, welding, assembly installation, laying, inspection during construction, testing, commissioning, operation, inspection, maintenance, modification, abandonment and safety aspects of onshore cross country pipelines transporting crude oil, condensate, liquid petroleum product, Natural Gas Liquid (excluding LPG (Liquefied petroleum Gas) between the following facilities as per the scope defined in Annexure-I.

a) 1st valve at Land Fall Point of offshore pipeline and inlet valve of onshore storage Tank(s).
b) Onshore storage Tank(s) manifold (marine / rail / road terminal) to manifold of Refinery / process plant storage tank(s).
c) Manifold of cross country pump station to manifold of product / crude storage tanks(s) at delivery terminal (marine / road / rail).
d) Group Gathering station including intermediate group gathering station to pump station and/or manifold of bulk storage facilities of Tank farm / Refinery / process plant.

2.2 This standard shall be applicable from the date of issuance mentioned on title page for all new projects / extension or expansion of existing system. For new pipelines under construction and commissioning phase and also for existing pipelines and associated facilities under operation phase, the requirements related to safety & fire protection system, operation & maintenance, pipeline integrity management, defect detection, assessment & mitigation specified in this standard shall be applicable. It shall be obligatory on the part of Owner/Operator to implement/comply these requirements within 2 years of issuance of this Standard for pipelines already in operation and within 2 years of commissioning of pipelines which are under construction phase.

2.3 This standard does not cover :-
1. The marginal offshore portion of the onshore pipeline, if any which shall be governed by OISD-Std-139.
2. Cross country pipelines transporting liquefied petroleum gas (LPG) which is covered in OISD-Std-214.
3. Onshore pipeline transporting natural gas which is covered in OISD-Std-226 (Part- I)
4. Well fluid lines from oil well to gathering station.

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

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

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Competent Authority
Any person appointed / authorized by Central Government, by notification in the official Gazette to perform the functions of the competent authority under the PMP Act’1962 or any other Act as per the requirement.

Competent person
A person recognized by Owner / Operator based on his proficiency, skill, appropriate education, training and experience.

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

Cross country Pipeline:
Cross country pipeline means all pipeline located beyond the boundary of any facility including pipelines after separator (exploratory well) and its associated facilities which are required for transportation of liquid hydrocarbon from one point to another excluding piping within the Refinery/ Separation and / or Processing plant up to plant isolation valves.

Coating
A material applied to a pipeline / structure to separate it from the environment for preventing corrosion.

Cathodic protection
A technique to control the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Cathodic disbondment:
The destruction of adhesion between a coating and coated surface caused by products of cathodic reaction.

Chief Controller
Means Chief Controller of Explosives.

Consequence
Means impact on the public, employees, property and environment due to pipeline failure.

Design Factor
It is percentage factor of Specified Minimum Yield Strength (SMYS) of the material considered for determining wall thickness of pipe based on location of the pipeline.

Design Pressure
The maximum internal pressure which the pipeline can be subjected to as determined by design procedure applicable to materials and locations involved.

Electrical bonding
A metal piece having very little electrical resistance used for connecting two points on the same or different pipeline structure.

Earthing
Earthing is provision of a safe path of electrical current to ground in order to protect structures, plant and equipment from the effects of stray electrical current and electrostatic discharges.

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
Functional Safety
It is a part of the overall safety that depends on a system or equipment operating correctly in response to its inputs.

Hazard Analysis
It is to identify significant hazards for equipment and any associated control system in its intended environment with probabilities of occurrence and impacts.

Hot work
It is an activity which involves welding, burning, soldering, brazing, sand blasting, 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.

High Consequence Areas:
An area where 46 or more dwelling intended for human occupancy in a stretch of 1600 meter along the pipeline and 200 meter on either sides of the pipeline centreline.

Intermediate pigging stations:
An intermediate pigging station is an installation having facility for receiving and launching of pigs for pipeline pigging operations and is located between originating and delivery stations.

Intermediate pump station
An intermediate pump station is any installation having facilities such as pumps etc. between originating pump station and intermediate pigging station and / or terminal station / receipt station for boosting the pressure of the liquid required to reaches to next station.

Intermediate delivery station / Tap off Station (TOP)/ Tap off Points
An intermediate delivery station / Tap off station/ Points on the pipeline installation is an installation having facility to deliver product to any industry (ies) / storage tanks through a tapping from the mainline. Delivery can be through heart cut or full cut.

Land Fall Point
A place on the land after the offshore area where a valve is installed to separate the offshore and onshore part of the pipeline.

Layers of Protection: Layers of protection are the systems or actions and devices that are capable of preventing a scenario from proceeding to undesired consequences.

Layers of Protection Analysis (LOPA)
LOPA is a simplified semi-quantitative technique of risk analysis. It helps to assess what independent protection layers (IPL) already exist or what are required for process safety.

Maximum Allowable Operating Pressure (MAOP)
The maximum pressure at which the pipeline is allowed to operate. MAOP may be less than or equal to the design pressure.

Maximum Operating Pressure (MOP)
The highest pressure at which the pipeline is operated during a normal operating cycle corresponding to a declared pipeline capacity.

Multiphase Fluids
"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Multiphase fluids means oil, gas or water in any combination produced from one or more oil wells or recombined oil well fluids that may have been separated in passing through treatment/processing facilities. For the purpose of this standard, multiphase fluids are considered to be low vapour pressure fluids.

**Nominal Pipe Size**
It indicates the standard pipe size when followed by a number.

**Nominal wall thickness**
It is the thickness of the pipe used in design calculation.

**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.

**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.

**Onshore**
Areas not covered by 'Offshore' as defined above forming scope of this standard. Feeder lines from Jetty or other storage point and spur lines will form part of the onshore pipeline.

**Originating Station**
Originating station is the first installation in the cross country pipeline where the liquid hydrocarbon is received for further transportation.

**Originating Pump Station:**
An originating pump station is the first installation in the cross country pipeline having pumps for boosting the pressure of the liquid hydrocarbon to be transported so that it reaches to next station in the cross country pipeline

**Owner**
Shall mean individual, partnership, corporation or public agency / organization or any other entity that owns the cross country pipeline.

**Operating Company**
Shall mean individual, partnership, corporation or public agency / organization or any other entity that operates cross country pipeline.

**Pipeline System**
Means all pipelines as defined in para 2.0 of this standard transporting liquid hydrocarbons with associated safety systems, equipment, valves, tool launchers or receivers, manifolds, corrosion protection system or other accessory equipment.

**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.

**Right-of-User (RoU) / Right-of-Way (RoW)**

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
The area or portion of land within which the pipeline operating company has acquired the right through PMP Act’1962 or in accordance with the agreement with the land owner or agency to lay and operate the cross country liquid hydrocarbon pipeline.

Safety Integrity Levels (SIL)
This defines the Target Risk Reduction factor & Target average probability of Safety availability. The SIL as per IEC-61508 is given in clause 6.0.

Specified Minimum Yield Strength (SMYS)
It is the minimum yield strength specified by specification or standard under which material is purchased from the manufacturer.

Spur / Branch Pipeline
Pipeline originating from cross country pipeline (also called as trunkline pipeline) for dedicated terminal and/or customer location(s).

Sectionalizing Valve (SV)
Valve (MOVs / HOVs) used in the cross country pipeline system for isolation of a particular pipeline section whenever required. This valve is also referred as main Line valve (MLV).

Supplier Company
The company or organization owning and operating pipeline system for delivery to various industry (ies) / oil marketing companies.

Sour liquid hydrocarbon
A type of liquid hydrocarbon that contains H2S under partial pressure and / or presence of elemental sulphur 0.5% by weight.

Sump tank
An underground tank installed at pipeline station to store hazardous liquid which is released from pressure relief system / filters / scrapper barrels / piping of stations and subsequently re-injected to either the pipeline system and / or other storage tanks.

Weight Coating
Coating done on the pipeline for increasing the pipeline section specific gravity for the purpose of giving anti-buoyancy effect.

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

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

Terminal Station / Receiving Station / Receipt Terminal
Terminal / Receiving station / Receipt terminal is the last station on the pipeline used for receipt of liquid hydrocarbon.

4.0 Statutory Acts and Regulations
Liquid hydrocarbon pipeline and its associated facilities are covered under various regulations and require specific approval from concerned authorities. Various regulations, inter alia applicable are as under:
  i. The Environment (Protection ) Act -1986
  ii. Water ( Prevention & Control of Pollution) Act 1974

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
iii. Air (Prevention & Control of Pollution) Act 1981
vii. The Explosive Act, 1884.
viii. Manufacture, Storage & Import of Hazardous chemical Rules-1989
ix. National Highway Act, 1956
x. Railway Act, 1989
xi. The Factories Act 1948
xii. Building & Other Construction Worker’s Act’1996.
xv. Oil Mines regulation 1984 and its subsequent Amendment (if any).

In addition all other statutory approvals required for laying of the pipelines across rail, road and water body (canals/rivers etc.) crossings and other utility crossings as notified by local authorities / State etc. shall be applicable.

5.0 DESIGN
The pipelines shall be designed in a manner that ensures adequate public safety under all conditions likely to be encountered during installation, testing, commissioning and operating conditions. All materials and equipment shall be selected to ensure safety and suitability for the condition of use.

Design for pipeline system shall be based on the following evaluation of the properties and required flow rate of the liquid to be transported, together with the environment in which the pipeline is to be installed.
a) Sweet or sour liquid, single or multiphase flow conditions.
b) Operating pressures and temperatures.
c) Services i.e. crude / single product / multi product

Design of liquid hydrocarbon pipeline shall be in accordance with ASME B 31.4 unless specified. In case of discrepancies, this standard shall precede over ASME B 31.4.

Section(s) of cross country pipeline to be installed across estuaries and creeks etc. affected by tidal fluctuations, waves and currents and cannot be installed using conventional onshore equipment shall be designed in accordance with OISD-STD-139.

5.1 Pipeline Design

5.1.1 A design Life of minimum 25 years for pipeline system in general should be considered by the owner for designing various system and facilities. The life of pipeline can be extended beyond the design life subject to satisfying the comprehensive pipeline integrity test.

5.1.2 All necessary calculations shall be carried out to verify structural integrity and stability of the pipeline for the combined effect of pressure, temperature, bending, soil/pipeline interaction, external loads and other environmental parameters as applicable, during all phases of work from installation to operation. Such calculations shall include but not limited to the following:

a) Buoyancy control and stability analysis for pipeline section to be installed in areas subjected to flooding/submergence,
b) Crossing analysis of rivers by trenchless techniques, wherever soil data is favourable for such operation,
c) Evaluation of potential for earthquake occurrence across fault locations and carrying out requisite seismic analysis to ensure safety and integrity of the pipeline system.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.1.3 While designing the pipeline system, the design engineer shall provide reasonable protection to prevent damage to the pipeline from unusual external conditions. Some of the protective measures which the design engineer may provide are encasing with steel pipe of larger diameter, adding concrete protective coating, increasing the wall thickness of the pipe, lowering the pipeline to a greater depth or indicating the presence of the pipeline with additional markers.

5.1.4 Environmental Impact Assessment (EIA) and Risk Analysis (RA) study shall be carried for the pipeline and stations. Recommendations / findings from such studies to be taken into account while designing the pipeline system.

5.1.5 Design Temperature
Appropriate temperature range for design of pipeline / piping system shall be determined based on temperature of liquid hydrocarbon proposed to be transported through the pipeline, ambient / sub-soil temperature.

5.1.5.1 Maximum temperature
Maximum temperature for design of above ground section of pipeline / piping shall be the maximum expected liquid temperature during operation or maximum ambient temperature whichever is higher. In no case maximum temperature for carbon steel pipelines shall be more than (+) 120°C.

Maximum temperature for design of buried section of pipeline / piping shall be maximum expected liquid hydrocarbon temperature during operation or maximum sub-soil temperature whichever is higher.

5.1.5.2 Minimum temperature
Minimum temperature for design shall be minimum expected liquid hydrocarbon temperature during operation or minimum ambient / sub-soil temperature whichever is lower. In no case minimum temperature for carbon steel pipelines shall be less than (-) 29°C.

5.1.5.3 When maximum liquid hydrocarbon temperature during operation is below 65 °C, thermal expansion and stresses in the above ground section of pipeline / piping shall be evaluated considering pipe skin temperature of 65 °C.

5.1.6 Straight Pipe

5.1.6.1 Pipe diameter 4" NB and above shall be used for cross country pipelines. Pipe wall thickness less than 5.5 mm should not be used for cross country pipelines.

5.1.6.2 The nominal wall thickness "t" for the steel pipe, shall be calculated in accordance with ASME B 31.4. The internal design pressure wall thickness t of steel pipe shall be calculated by the following equation:

\[
t = \frac{P_i \times D}{2S}
\]

Where
- \( D \) = outside diameter of pipe, in.
- \( P_i \) = Internal design gauge pressure, psi (Refer note 2 below).
- \( S \) = applicable allowable stress value, psi
- \( F \times E \times SMYS, \) Psi
- \( F \) = Design Factor from Table-1
- \( E \) = Longitudinal joint factor, which for electric welded (EW), longitudinal seam submerged arc welded (LSAW), helical seam submerged arc welded (HSAW) and seamless types of pipes, manufactured in accordance with API specification 5L and considered as 1;
- SMYS = Specified Minimum Yield Strength

Note:
“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
1) The above wall thickness design shall be considered applicable for metal temperature between (-) 29°C and (+) 120°C.

2) The internal design pressure shall be at least equal to maximum steady state operating pressure which shall be the sum of the static head pressure, pressure required to overcome friction losses, and required back pressure. In calculation of internal design pressure, credit may be given to external hydrostatic pressure appropriately.

3) The nominal wall thickness shall be calculated as, $t = \text{design wall thk.} + A$, where, $A =$ sum of allowance for threading & grooving, corrosion allowance and increase in wall thickness if used as protective measures in para 5.1.6.3 of this standard.

<table>
<thead>
<tr>
<th>TABLE-1 : Design Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Facility</strong></td>
</tr>
<tr>
<td>Pipelines, mains, and service lines</td>
</tr>
<tr>
<td>Crossings of roads, railroads without casing:</td>
</tr>
<tr>
<td>(a) Private roads, Unimproved Public Roads</td>
</tr>
<tr>
<td>(b) Roads, highways, public streets, with hard surface</td>
</tr>
<tr>
<td>(c) Railroads</td>
</tr>
<tr>
<td>Crossings of roads, railroads with casing</td>
</tr>
<tr>
<td>Parallel pipelines and mains roads and railroads:</td>
</tr>
<tr>
<td>(a) Private roads, Unimproved public roads</td>
</tr>
<tr>
<td>(b) Highways, or public streets, with hard surface and railroads</td>
</tr>
<tr>
<td>Pipelines on bridges</td>
</tr>
<tr>
<td>River Crossings</td>
</tr>
<tr>
<td>Dispatch terminal, intermediate pumping &amp; pigging station, receipt/ terminal piping &amp; other stations piping</td>
</tr>
</tbody>
</table>

# Note: 1: At these locations, pipes of heavier wall thickness shall be used.

5.1.6.3 Additional Requirements for Nominal Wall Thickness “t” in Para 5.1.6.2

(a) The minimum wall thickness ‘t’, required for pressure containment as determined by para 5.1.6.2 above, may not be adequate for other forces to which the pipeline may be subjected.

(b) Corrosion allowance to account for expected loss of wall thickness due to internal corrosion that may be caused due to constituents of the liquid hydrocarbon and other service conditions shall be added to the calculated thickness unless other internal corrosion mitigation measures are adopted.

(c) In addition, the selected thickness shall also be checked to ensure that the diameter to thickness (D/t) ratio does not exceed 100 in order to avoid damage to pipe during handling and transportation.

5.1.6.4 Other Loadings

Other loadings such as those caused by scour, erosion, soil movement and landslides, installation forces, wind loading, earth quake loading etc. shall be considered and provided for in accordance with sound engineering practices.

Weight of water during hydrostatic testing and weight of product during operation shall also be considered.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.1.6.5 Limit of calculated stresses

5.1.6.5.1 Allowable Expansion Stress

The net longitudinal compressive stress due to the combined effects of temperature rise and fluid pressure shall be computed as under.

a) Restrained Lines:

\[ S_L = E \alpha (T_2 - T_1) - \mu S_h \]

Where,

- \( S_L \) = The longitudinal compressive stress, psi (MPa)
- \( S_h \) = Hoop stress due to internal fluid pressure, psi (MPa)
- \( T_1 \) = Temperature at time of installation, °F (°C)
- \( T_2 \) = Maximum or minimum operating temperature degrees, °F (°C)
- \( E \) = Modulus of Elasticity of steel, psi (MPa)
- \( \alpha \) = Linear coefficient of thermal expansion, inch / inch / °F (mm / mm / °C)
- \( \mu \) = Poisson's ratio = 0.30 for steel

The net longitudinal stress becomes compressive for moderate increases of \( T_2 \) and that according to the commonly used maximum shear theory of failure, this compressive stress adds directly to the hoop stress to increase the equivalent tensile stress available to cause yielding. This equivalent tensile stress shall not be allowed to exceed 90% of the SMYS of the pipe, calculated for nominal pipe wall thickness. Beam bending stresses shall be included in the longitudinal stress for those portions of the restrained line which are supported above ground.

b) Un-Restrained Lines:

Stresses due to expansion for those portions on the piping without substantial axial restrain shall be combined in accordance with the following equation:

\[ S_E = \sqrt{S_b^2 + 4S_t^2} \]

Where,

- \( S_E \) = Stress due to expansion, psi (MPa)
- \( S_b = \sqrt{\left( \frac{i_i M_i}{Z} \right)^2 + \left( \frac{i_o M_o}{Z} \right)^2} \)
  - Equivalent bending stress, psi (MPa)
- \( S_t = \frac{M_t}{2Z} \)
  - Torsional stress, psi (MPa)
- \( Z \) = Section modulus of pipe, inch³ (cm³)

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
\[ M_t = \text{Torsional moment, in. lb. (N.m)} \]

\[ M_i = \text{Bending moment in plane of member (for members having significant orientation, such as elbows or tees, for the latter the moments in the header and branch portions are to be considered separately), in. lb. (N.m)} \]

\[ M_o = \text{Bending moment out of, or transverse to, plane of member, in. lb. (N.m)} \]

\[ i_i = \text{Stress intensification factor under bending in plane of member [Refer ASME B31.4]} \]

\[ i_o = \text{Stress intensification factor under bending out of, or transverse to, plane of member [Refer ASME B31.4]} \]

The maximum computed expansion stress range, \( S_E \), without regard for fluid pressure stress, based on 100 per cent of the expansion, with modulus of elasticity for the cold condition, shall not exceed 72% of the specified minimum yield strength of the pipe.

**5.1.6.5.2 Other Limiting Stress Value**

a) The sum of longitudinal stresses due to pressure, weight, and other sustained external loadings shall not exceed 75% of the allowable stress value specified in para 5.1.6.2 above.

b) The sum of the longitudinal stresses produced by pressure, live and dead loads, and those produced by occasional loads, such as wind or earthquake, shall not exceed 80% of the specified minimum yield strength of the pipe. It is not necessary to consider wind and earthquake as occurring concurrently.

c) The sum of the circumferential, longitudinal, and radial stresses from internal design pressure and external loads in the pipe installed under rail-roads or highways, as combined in API RP 1102 shall not exceed 90% of the SMYS. Loads shall include earth load, cyclic rail load, and thermal stresses.

d) It is not necessary to consider other occasional loads, such as wind and earthquake, as occurring concurrently with the live, dead and test loads existing at the time of test.

**5.1.7 Pre – Operational stresses**

It is desirable to limit stresses during pre-operational manipulation of the pipe so as to avoid damage that might impair the operability of the line. The designer shall ensure that pre-operational stresses are controlled and that they are non-injurious to the pipe. Consideration shall be given to, but not restricted to, the effect of the following pre-operational loads:

a) Transportation and stockpiling of the pipe;
b) Stringing, coating and wrapping, and laying;
c) Backfilling;
d) Loads imparted by construction traffic;
e) Field bending;
f) Pulling load during horizontal directional drilling.
g) Frictional load during jacking and boring.
h) Hydrostatic test pressure loads (particularly when the pipeline is constructed as an above ground installation or is buried in unstable soils).

**5.1.8 All cross country pipelines of size ≥ 4” NB and ≥ 10 km long shall be provided with pigging facilities. Refer para 5.6 for further details.**

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
5.1.9 Surge Analysis:
A detailed surge analysis shall be carried out during design stage considering the following condition:
(i) Closure of sectionalizing motor operated valve (MOV) on the mainline
(ii) Closure of inlet MOV of the storage Tanks during receipt.
(iii) Closure of any MOV in the delivery pipeline.
(iv) Stoppage of Pump(s) at originating / Intermediate pump station.
(v) Closure of valves during emergency shutdown.
(vi) Combination of the above
(vii) Any other condition which can generate surge pressure.

In order to protect the pipeline against surge pressure, surge relief valve or equivalent measures such as suitable interlocks to trip the mainline pump through SCADA or station control system shall be provided. The required capacity needed to be relieved through surge relief valve shall be determined by carrying out the surge analysis for above different scenarios under which a surge may occur in the pipeline. The set pressure of surge relief valve shall be such that in any case the overpressure in the pipeline or connected piping system does not exceed the design pressure by more than 10%.

5.1.10 Anti-buoyancy Measure
Pipeline crossing water bodies, marshy areas, swamps and areas with high water table shall be checked for buoyancy and if required suitable anti-buoyancy measures such as continuous concrete weight coating or concrete block, gravel filled geotextile bags, anchors etc. shall be provided. The specific gravity of the same under empty/ installation conditions shall be minimum 1.1.

5.1.11 Corrosion
All underground pipes and its component shall be protected against corrosion using suitable external anti-corrosion coating / painting and cathodic protection system. All above ground piping and its component shall be protected against corrosion by providing suitable anti-corrosion coating. Wall thickness allowance in pipe for protection against corrosion may not be required if pipe and its components are protected against corrosion by any of the above method.

5.2 Location and Layout of Pipeline installation
5.2.1 Location
Originating, intermediate and terminal facilities of cross country pipeline such as Originating Pump Station, Intermediate pump / pigging Station, Tap-off Station and Sectionalizing Valve Stations etc. shall be located considering following aspects:
(i) Functional and pipeline hydraulic requirements.
(ii) Environmental consideration based on Environmental Impact Assessment (EIA) and Risk Analysis (RA) study for the pipeline and stations.
(iii) The HAZOP and risk analysis.
(iv) The availability of space for future augmentation of facilities.
(v) Approachability, water table and flood level and natural drainage.
(vi) Availability of electric power

In addition to above, pipeline installations should be located at such clear distances from adjacent property not under control of the pipeline owner / operator so as to minimize the hazard of communication of fire to the pump station from structures on adjacent property.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.2.2 Layout
The following aspects shall be considered while establishing station layout

(i) Station equipment including sump tanks(s).
(ii) P&I diagram for the station.
(iii) Utility requirement including other storage tanks like HSD for power generation etc.
(iv) Storm water drainage system.
(v) Operation & maintenance philosophy of station equipment.
(vi) Fire station & allied facility wherever required.
(vii) Proximity to overhead power lines. Overhead power lines should not be allowed directly above station equipment / buildings.
(viii) HT Pole structure, Transformers, Breaker and MCC room etc. to be located in non-hazardous area.
(ix) Requirement of space and access around the pump (including engine / motor) house/ shed / building and other equipment to permit the free movement of fire fighting equipment.

5.2.3 Separation Distances
Control room should be located far away from potential leak source as far as practicable. Inter-distance between various station facilities and utilities shall be as per Annexure- II. At pipeline installations for inter-distance among various facilities, provisions of this standard shall have precedence over OISD-STD-118.

5.2.4 Piping Layout
Station piping may be installed above ground or buried. Buried piping inside the terminal area shall have a minimum cover of 1.2 m from top of pipe to finished ground level.

At internal storm water drains underground piping shall be provided with a minimum cover of 300 mm with additional concrete slab extending at least 500mm on either side of the edge of the drain.

Where buried pipes come above ground, the anti-corrosion coating on the buried pipe will continue for a length of at least 300 mm above ground.

Platforms and crossovers with appropriate handrails shall be provided for accessibility, ease of operation and maintenance of above ground piping where required.

5.3 Protection of Facilities
5.3.1 Properly laid out roads around various facilities shall be provided within the installation area for smooth access of fire tenders etc in case of emergency.

5.3.2 Proper industry type boundary wall at least 3 meter high including 0.6 meter concertina coil on top shall be provided all around the installation i.e pump station, Intermediate pigging station, tap-off points / terminals and sectionalizing valve stations (MOV) in line with MHA (Ministry of Home Affairs) guidelines.

5.3.3 Emergency exit (to a safe place) with proper gate(s) shall be provided at all installations such as pump station, intermediate pump stations, pump stations with tank farm, delivery / terminal stations. Emergency exit gate shall be away from main gate and always be available for use of personnel evacuation during emergency.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.3.4 At intermediate pigging station and sectionalizing valve station location Close Circuit Television (CCTV) camera and / or intrusion alarm system should be provided. At pump station, delivery / terminal station CCTV camera shall be installed at the security gate.

5.3.5 Cross country pipeline system shall be equipped with following:

(i) Supervisory Control and Data Acquisition (SCADA) System for pipeline length of 50 km and above or line fill of 5000 kl and above except jetty pipelines.

(ii) A system for leak detection with provision for identification / location of leak and isolation of affected section from remote operation for pipeline length of 50 km and above, or line fill of 5,000 kl and above.

5.4 SCADA Requirements

5.4.1 Pipeline system equipped with SCADA system provided inline with clause 5.3.5(i) above shall be monitored and controlled from SCADA to ensure effective and reliable control, management and supervision of the pipeline with an objective for:

(a) Real Time monitoring of various pipeline parameters like Pressure, Temperature, Flow, Status of equipment.

(b) Leak detection.

(c) Remote control operations for Open / Close of valves during emergency shutdown.

5.4.2 Originating Pump Stations, Intermediate Pump Station, Intermediate Pigging Stations, Intermediate Delivery Station and Receiving / terminal Stations, Sectionalizing Valve stations with remote operation capabilities as well as Telecom Repeater Stations / Cathodic Protection Stations (in case located independent of other facilities) should have suitable field signals' connectivity with the control system.

5.4.3 Application software modules/ functions should be based on the requirement of pipeline operating company to enable as a minimum to detect the leak in the pipeline and also enhance safety of the pipeline and personnel as well.

5.4.4 The provision for following Application Software (APPS) modules / functions may be provided:

a) Leak detection and leak location.

b) Inventory Analysis.

c) Batch Tracking

d) Survival Time Analysis.

e) Pipeline transportation efficiency and scrapper tracking module.

f) Contingency Analysis.

g) Planning Module.

h) Predictive Module.

i) Pump driver power Optimisation.

j) On line network simulation.

k) Flow management system.

5.4.5 The SCADA system should be adequate (without adding any hardware to the system at Master Station and remote workstations) to accommodate 50% future expansion (w.r.t. additional PLCs and consequent pipeline length and facilities, communication channels, additional remote workstations/ stations etc.) without any limitations and without affecting the various system performance parameters.

5.4.6 The Communication protocol with RTU’s should conform to IEC 870-5-101 or DNP3 or MODBUS or TCP / IP or any other available protocol.

5.4.7 Master Station (MS) should have the complete SCADA database and integrated alarm and event summary for overall operations management & control of the entire pipeline network.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.4.8 Control Station (CS) / RCP (Repeater cum Cathodic Protection) location should not be located in low lying areas prone to flooding. It should be preferably located in higher elevations.

5.5 Pipeline / Station Valves

5.5.1 Station Valves
Block valves with remote shut off provision from the control room shall be provided at the inlet (downstream of Tee) and outlet (upstream of Tee) of the pump / intermediate pigging / terminal / delivery station piping to isolate the pipeline from station facilities in case of emergency at station.
In addition, Block valves shall be considered at entry and exit of pipeline stations boundary.

5.5.2 Station bye pass
Station bye pass system shall be provided to facilitate flow of liquid hydrocarbon in the pipeline bypassing the pumping facilities inside the station premises.

5.5.3 Check valves
Check Valves shall be installed to provide automatic blockage of reverse flow in the piping system, within the station, wherever required. Check valves, when provided to minimise pipeline backflow at locations appropriate for the terrain features (e.g. hills, steep slopes, etc.), shall be suitable for passage of all types of pigs including instrumented pigs.

5.5.4 Flow/Pressure Control Valve
Design of control valves in stations shall meet the requirement of part I of API 550 / API-RP-553, ISA (Instrument Society of America) S- 75.01 -75.03, IEC -79 and IEC-529

5.5.5 Main Line Valves (MLV) / Sectionalizing Valves.

5.5.5.1 Sectionalisation valve shall be provided for isolating sections of pipeline and station in order to:
   a) Limit the hazard and damage from accidental discharge from pipeline ;
   b) Facilitate repair / maintenance of pipeline.

5.5.5.2 Sectionalizing valves shall be installed where required for operation and maintenance and control of emergencies. Factors such as topography of the location, ease of operation and maintenance including requirements for section line fill shall be taken into consideration in deciding the location of the valves. However, in any case the distance between two consecutive sectionalizing valve shall not be more than 50 km.

5.5.5.3 Sectionalizing valves shall be installed on upstream and downstream of perennial river crossings and public water supply reservoirs.

5.5.5.4 The valve stations shall be located at a readily accessible location such as near roads and shall be provided with an access road from the nearest all weather metalled road. The facilities within valve station shall be secured by providing a suitable boundary wall / fencing around the installation with a gate. Overhead power lines shall not cross directly over the valve station facilities.

5.5.5.5 The provisions of remote operated feature should be as per the operation and control philosophy to be adopted for the pipeline by the owner / operating company. At locations where valve stations are combined with pump / repeater stations, the requirements of safe distance and statutory clearance, as applicable, shall be followed.

5.5.5.6 Valve shall be installed buried and provided with a stem extension in such a way that the centre of wheel / actuator is at approximately 1.0 m above the finished ground level considering ease of operation. Sectionalizing valve on the main pipeline shall preferably be ball valves of full bore type conforming to the minimum requirements of API 6D / ISO-14313 – “Specification for pipeline valves”. Isolation of earthing of actuator to be done to avoid interference in C.P.

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
5.5.5.7 Pipeline sectionalizing valve may be manually / electrically / pneumatically or hydraulically operated. In order to minimize potential leak sources, valves used in mainline shall be with butt-weld ends. Flanges may be used where frequent access or removal of equipment is required. Valves used in buried portion shall be with butt weld joints only, except at the locations where hot tapping operation is to be carried out for which, buried flanged end valve may be provided. Valve surface shall be applied with suitable corrosion protection coating.

5.5.5.8 All joints between the mainline pipe and the first valve, including the inlet to first valve, should be welded in order to restrict possible future leakage which cannot be isolated by the closure of the valve.

5.6 Pigging Facilities

5.6.1 All cross country pipelines and feeder lines, spur lines and branch lines of length 10 km and above shall be provided with pigging facilities. However, pigging facilities for pipeline from / to jetty may be provided on need basis.

5.6.2 Spacing between consecutive pigging stations shall be determined based on the diameter of pipeline, type of product, nature of pigging operation and capability of the pigs.

5.6.3 Pigging stations shall be provided with all-weather access road from the nearest road.

5.6.4 Pigging facilities should be designed to be suitable for:
   a) access to the pig traps;
   b) handling of pigs;
   c) isolation requirements necessary for pig launching and receiving;
   d) draining of carried over muck / condensate during pigging operation;
   e) direction of pigging including bi-directional pigging;
   f) minimum permissible bend radius and the distances between bends/fittings;
   g) variation in pipe diameter and wall thickness;
   h) internal coatings; and
   i) pig signallers.

The safety of access routes and adjacent facilities shall be considered when determining the orientation of pig traps.

5.6.5 Pig Traps / Pig Barrels

5.6.5.1 Pig traps shall be capable of handling displacement pigs, cleaning pigs, swabbing pigs, calliper pigs and intelligent pig. Diameter of pig barrel shall be suitable for handling all type of pigs. Barrel for launcher may be 2 size higher and barrel for receiver may be 3 size higher than mainline liquid transporting pipe size. The pig barrel shall be provided with quick opening end closures equipped with safety locking device. Pig traps shall be designed as per ASME B31.4 and quick opening end closure shall be designed in compliance with ASME section VIII of BPV code.

5.6.5.2 Suitable arrangements for launching, retraction, handling and lifting of pigs shall be provided

5.6.5.3 Mechanical and Electronic (optional) Pig signallers shall be installed on the pipeline and pig barrels to track the passage of pigs.

5.6.5.4 Centreline elevation of pig barrel shall be such as to allow easy insertion / retraction of pigs and operation of quick opening closure. Elevation of approximately 1.0m above finished grade / pavement level is recommended.

5.7 Bends

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
The minimum radius of Cold Field Bend shall be as per Table -2 below. Use of Mitre bend shall not be permitted. Factory made bend of bend radius less than 3D shall not be permitted.

<table>
<thead>
<tr>
<th>Nominal Pipe Size (inch)</th>
<th>Minimum Bend Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 and below</td>
<td>30 D</td>
</tr>
<tr>
<td>18 and above</td>
<td>40 D</td>
</tr>
</tbody>
</table>

Where ‘D’ is the outside diameter of the steel pipe.

5.8 **Insulating Joints**
Insulating joints shall be provided to electrically isolate the buried pipeline from the above ground pipeline. Insulating joints shall be monolithic type and shall allow smooth passage of pigs. Insulating joints separating buried and above ground pipeline shall be installed in above ground portion of pipeline, immediately after the buried /above ground transition point. Each insulating joint shall be provided with surge diverters and shall have provision for checking integrity of the insulating joint.

5.9 **Branch Connection**
5.9.1 Branch connections of size below NPS 2 are not recommended in buried pipeline section.
5.9.2 All branch connections from mainline shall be provided with an isolation valve located at a minimum possible distance from the main pipeline.
5.9.3 All branch connections or side tap on the piggable section of the pipeline having diameter equal to or exceeding 40 percent of the main pipe diameter, shall be made using flow tees / bar tees in order to enable smooth passage of all types of pigs. Such flow tees / bar tees shall comply with the requirements of ASME B 16.9, MSS-SP-75 or equivalent.

5.10 **Supports for above ground station piping**
5.10.1 Due consideration shall be given to the effect of such attachments on possible fatigue failures and local stress concentrations.
5.10.2 Wherever non integral attachments, such as pipe clamps and ring girders are used, adequate precautions shall be taken to prevent corrosion at or near the contact points.
5.10.3 If the liquid hydrocarbon piping is required to operate below 20% of SMYS, supports or anchors shall be directly welded to the pipe.
5.10.4 If a pipeline is designed to operate at stress level of more than 20% of the specified minimum yield strength of the pipe, all connections welded to the pipe shall be made to a separate cylindrical member which completely encircles the pipe, and this encircling member shall be welded to the pipe by continuous circumferential welds at both ends.

5.11 **Flanged or threaded joints, Bolts, Nuts, Gasket and other fittings**
5.11.1 Threaded joints shall not be used in the underground section of cross country pipelines, spur lines and branch lines. Threaded joints may be permitted in the above ground stations / above ground section of SV stations only if a welded isolation valve is provided before it. The number of flanged or threaded joints for station piping shall be to the extent minimum. The threaded joints, after tightening, may be seal welded. Flanges shall conform to ANSI B 16.5 or ASME B 16.47 or MSS-SP 44 or equivalent.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
5.11.2 The flange joint shall be provided with either spiral wound metallic gaskets or metallic ring type gaskets, depending upon the piping class. Plain asbestos sheet / reinforced gaskets shall not be used.

5.11.3 Steel butt welding fittings shall comply with ANSI B 16.9 / MSS-SP-75 or equivalent. Weld’O’ lets shall comply with MSS SP 97. Steel socket welding fittings shall comply with ANSI B 16.11.

5.12 Metering facilities
Positive displacement meters, turbine meters, ultrasonic meters, mass flow meters or any other equivalent measuring device with the desired accuracy shall be installed at all stations for leak detection or other purposes. Mass flow meter with integrator shall be provided on all delivery lines for custody transfer.

5.13 Electrical Installations of Pipeline Station

5.13.1 Area Classification of Pipeline Installation, as basis for Selection of Electrical Equipment for liquid hydrocarbon Pipeline Station shall follow IS-5572 and OISD –STD-113 Standards. The specification of Electrical equipment shall be in line with IS: 5571, “Guide for selection of Electrical Equipment for Hazardous Area”. Safety in electrical system to be designed as per OISD-RP-149. Fire protection in Electrical installations shall be designed as per OISD-STD-173.

5.13.2 All electrical equipment, systems, structures and fencing shall be suitably earthed conforming to IS 3043. The earthing system shall have an earthing network grid with required number of electrodes. All Electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grids. Separate earthing grid shall be provided for instrument and electrical system. Lightning protection shall be provided as per the requirements of IS: 2309. Self-conducting structures having metal thickness of more than 4.8 mm may not require lightning protection with aerial rod and down conductors. They shall, however, be connected to the earthing system, at least, at two points at the base in line with OISD-STD-173.

6.0 Safety Instrumented System (SIS)

6.1 Safety Instrumented System (SIS) is composed of software & hardware which takes the process to a safe state when predetermined conditions, as set on control parameters like pressure, temperature, levels, flow etc, are violated. SIS protects against the possibility of a process excursion developing into an incident and limits the excursion potential.

6.2 The safety instrumentation system (SIS) required as minimum for cross country liquid hydrocarbon pipelines shall be as under:-

6.2.1 At each station of cross country pipeline, provision of Emergency Shutdown (ESD) shall be made for isolation of the station. Requirement for isolation of specific segments as identified through PHA (Process Hazards Analysis) study shall also be met through additional shutdown valves. Refer clause 8.7 of this standard for details. ESD for entire pipeline system shall also be designed, installed and made operable from Master Control Centre (MCC).

6.2.2 SIS requirement for Surge relief should be identified through surge analysis of the pipeline and accordingly provision shall be made.

6.2.3 Storage tanks and line balancing tanks at each location shall have alarm for level High and trip / close for high-high and low- low level of liquid hydrocarbon level in the tank. Thermal safety valve (TSV) shall be provided at the operating manifold (outside dyke).

6.2.4 Hydrocarbon detectors shall be installed near all potential leak source of Class A and Class B pump house manifold.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
6.2.5 General minimum requirements towards safety instrumentation shall be covered as under:

**6.2.5.1 Safety Instrumentation system for Mainline Pumps**

Main line pumps are the pumps used for liquid hydrocarbon transportation through cross country pipelines. The pumps considered here are electrical motor driven / I.C engine driven centrifugal pumps. It is also considered that the pumps are located in the field and all parameters related to the pumps are controlled from the control room. All the machine safety features as provided by the OEM (Original Equipment Manufacturer) / vendor should be integrated with the alarm system and pump trip logic. Protection be provided for the following:

i. High pressure sensor in the pump discharge for alarm & to trip the pump.
ii. Low pressure sensor in the pump suction for alarm and to trip the pump.
iii. Low discharge pressure trip for protection against pipe rupture, if required
iv. High casing temperature alarm
v. High bearing temperature alarm
vi. Motor operated valves (MOVs) provided on upstream and downstream of the pump which shall be coupled to the start and operation of the pump logic. Pump shall trip in case MOVs at suction/ discharge get closed and vice versa.
vii. In case of double seal pump, alarm to be provided in the event of primary seal failure. Pump ESD to activate in case of seal failure to ensure closure of suction and discharge valve of mainline pump to prevent hydrocarbon spillage thru failed seal.”

viii. **Protections in line with manufacturer's (OEM) recommendations**, such as:
   a. Vibration trip at high-high vibration
   b. Temperature sensors (RTD/ Thermocouple type) for monitoring of bearing and casing temperatures and trip
   c. Motor bearing and winding temperature indicators for each phase, with alarms/trips.

**6.2.5.2 Motors:**

In addition to manufacturer's recommendations on Motors, Drives and their instrumentation, Following status feedbacks and protection shall be provided for each Motors / Drive:

(a) Monitoring:
   i. Status feedback contacts i.e. ON / OFF/ TRIP
   ii. Device selection contact i.e. Remote / Local / Field
   iii. Current
   iv. Voltage
   v. Frequency
   vi. Power Factor
   vii. Energy
   viii. Vibration for new HT motors

(b) Protection:
   i. Winding temperature with Alarm & Trip settings – For each Phase.
   ii. Bearing temperature with Alarm & Trip settings – DE & NDE.
   iii. VFD cell temperature – Highest of all cells.
   iv. Bearing lubrication pressure (For forced cooling system).
   v. Bearing lubrication temperature (for forced cooling system).
   vi. Vibration with Trip settings.

**6.2.5.3 Engines:**

Apart from Electrical drives, Engines (using Crude Oil, Diesel or both as fuels) are also used to drive Main Line Pumps. In addition to manufacturer’s recommendations on instrumentation, Engines shall be provided with following safety instrumentation:

i. Low Pressure sensor for instrument air.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
ii. Low pressure sensor on fuel supply.
iii. High temperature sensors on gear box pinion bearing and wheel bearing, engine bearing, engine jacket cooling water.
iv. Oil Mist detector (OMD) or equivalent.
v. CO2 purging system in case of high OMD detection for mist or equivalent.
vi. High temperature sensor for lube oil.
vii. Provision of sensors for Low Lube oil pressure for Engine & Gear-Box and High Exhaust Temperature.

6.2.5.4 Storage at receiving / delivery terminals.

i. High, High-High level alarm for the storage receiving material delivered by the pumps. The audio visual alarm shall be provided at local panel and the pipeline control room.
ii. Pipeline delivery MOV/ROVs shall close on actuation of High-High level alarm.

6.3 Instrumentation and control system for the Pipeline system in totality shall meet the requirement as per API Standard API-RP-551 to API-RP-556 “Manual on Installation of Refinery Instruments and Control Systems.”

6.4 The following codes and standards may be used for design of electrical / instrumentation works.
   a) ISA S 51.1 - Process Instrumentation Terminology.
   g) IEC 1000 – Electromagnetic Compatibility for Industrial Process Measurement and Control equipment.
   h) IEC 228 Conductors of insulated cables.
   i) IEC 5831 – Specification for PVC insulation and sheath of insulated cables.

7.0 Communication
A reliable and dedicated communication system to interact between all stations including sectionalizing valve station with remote operation capability along the entire pipe line shall be designed and installed and maintained to ensure safe operations under both normal and emergency situations.

8.0 PUMP STATION
8.1 Pump Station shall be designed in accordance with the requirements of ASME B 31.4. Location and layout shall be designed in line with para 5.2 of this standard.

8.2 Pumps
8.2.1 Centrifugal type pump shall conform to the requirement of API-610. Reciprocating Pump shall conform to the requirements of API 674 or API 675 or API 676. Selection, operation and maintenance of pump shall be as per OISD-STD-119.
8.2.2 All Pumps shall be provided with suction and discharge pressure gauges and transmitters.
8.2.3 Check valve shall be installed on the discharge side of all centrifugal pumps wherever installed in parallel. Wherever pumps are installed in series, shall have check valve in the header isolating the suction and discharge piping connection. The last pump in the series shall have check valve

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
on the discharge piping. Additional common check valves shall be installed in the outlet header of the series pump configuration. The suction and discharge side of the main pumps and booster pumps shall have actuated valves.

8.2.4 Minimum flow circulation line shall be provided for booster pumps / main pumps in line with designer’s/ manufacturer’s recommendation.

8.2.5 Seal with seal failure alarms and trips shall be provided.

8.2.6 Following alarms / trips shall be provided on the main pumps:
   (i) Low suction pressure of booster and main pump.
   (ii) High discharge pressure at main pump.
   (iii) Low discharge pressure trip.
   (iv) High Casing temperature
   (v) Lube oil system trip.
   (vi) High bearing temperature
   (vii) Tripping of main/ booster pump in case of closure of suction / discharge valve
   (viii) Suction and Discharge valves limit switch position (open / close) to be interlocked with the start of the pump.
   (ix) Pump shall operate in sequence with defined logic at starting and shut down.
   (x) Tripping of pump at no flow condition or at a flow less than minimum continuous flow.

8.3 Pump Drivers
8.3.1 Electric Motors with fixed speed drive or variable frequency drive (VFD) may be provided as Pump Drivers. Electric Motors shall meet the requirement of API Standard 540 “Electrical Installation of Petroleum Processing Units”.

8.3.2 In case Internal Combustion Engines as pump drivers is provided, this shall meet the requirement of OISD-STD-127 “Selection, Operation and Maintenance of Diesel Engine” and API standard 7C - 11F - “Recommended practice for Installation, Maintenance and Operation of Internal Combustion Engines” or suitable BIS equivalent codes.

8.3.3 Air intake shall be located in a non-hazardous area. Screwed pipe fittings shall not be used on any part of the fuel system piping or on the day service tank. Seamless tubing with stainless compression fittings are recommended. If the flame arrester or traps are installed on the exhaust, it shall comply with BS 7244.

8.3.4 Exhaust manifolds and turbocharger casing shall be cooled as per OEM recommendations.

8.3.5 The control panel of the engine shall be designed for operating in hazardous area in case the same is mounted adjacent to the engine.

8.3.6 All electrical equipment shall be certified for use in hazardous area including electric starter motor and starter solenoids.

8.3.7 The radiator fan blades shall be as per OEM recommendations.

8.3.8 Safety Instrumentation system on the mainline engine shall be provided as per Annexure-IV. In addition to this, provision shall be made for shut down of the engine on high coolant or lubricating oil temperature.

8.3.9 Engines driving pumps used for pumping petroleum products class A and Class B shall be separated from the pump by means of fire wall of sufficient size to prevent liquids leaking from the pump from spraying onto the engine.”

8.4 Station Piping
Station piping for pump station, scrapper station, terminal station, Intermediate delivery or tap off station and pump cum delivery or tap off station shall be designed in accordance with para 5.1.6 of this standard.
The piping for auxiliary components including air, lubricating oil, hydraulic power piping etc shall be designed in accordance with ASME B 31.3.

8.5 Instrument and Plant Air System
Depending upon requirement, pump station should have an instrument air supply system for instrumentation system, control valves etc. Electrical motor driven or diesel driven air compressors shall be used. Air receivers, air storage bottles and instrument air dryer units shall be provided. Air receivers or air storage shall be designed and installed in accordance with ASME Section VIII of the Boiler and Pressure Vessel Code.

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
8.6 Building / Shed Requirements
Control room shall be designed in accordance with OISD-STD-163 “Safety of Control room for Hydrocarbon Industry”. Pump station / pump cum delivery or tap off station/ terminal station should have following main buildings/sheds, in general:-

(i) A pump shed to house the pumps and prime movers.
(ii) Switchgear building for electric power.
(iii) Alternate Power generator building /shed.
(iv) Battery room
(v) Workshop / maintenance building.
(vi) Warehouse store.
(vii) Office building.
(viii) Control room
(ix) Rest room, Pantry, Medical room etc.

Wherever the pipeline station (pump / pump cum delivery / delivery/ terminal) is common and / or located within the same premises of Marketing storage / despatch terminal, the control rooms for both marketing and pipeline terminal shall be located in the same operational building.

8.7 Emergency Shutdown (ESD) Facilities for stations
8.7.1 Pump station / pump cum delivery or tap off station/ terminal station shall be provided with an emergency shutdown system by means of which the operation can be safely stopped. Operation of the emergency shutdown system shall also shut down all Pumps, Prime movers, Control valves and delivery manifold valves except those that are necessary for protection of the equipment.

8.7.2 Emergency shutdown system shall be operable from at least 2 locations away from the pump shed area of the station out of which one should be located in the field outside the pump shed building and another in the control room of the pump station.

8.8 Pressure limiting devices
8.8.1 Any equipment or section of the pipeline containing liquid hydrocarbon in the form of trapped volume shall be protected against excessive pressure developed due to rise in surrounding temperature by installing Thermal Relief Valves (TRVs). The discharge of TRVs shall be connected to blow down drain connected to a sump tank of appropriate capacity. All TRVs shall have lock open type isolation valves on both sides of safety valve.

8.8.2 Pressure safety valves or other devices of sufficient capacity and sensitivity shall be installed to ensure that the normal operating pressure of the system does not exceeded by more than 10%. If the normal operating pressure is the maximum allowable operating pressure of the pipeline, then the set pressure for pressure safety valve should be at a pressure 2 kg / Cm2 above the MAOP or at a pressure equal MAOP plus 10%, whichever is less.

8.9 Sump Tank
Discharge from safety valves shall be connected to a close blow down system having an underground storage tank of appropriate capacity. In case surge protection measures are installed, the sump tank shall have adequate capacity to store the excess liquid hydrocarbon expected to be released as result of activation of surge relief system.

8.10 Fire Protection System

8.10.1 Ultra Violet /Infra-Red (Flame detectors) and heat detectors shall be installed in the pump shed to give automatic alarm and / or shut down of the unit, isolation of the facilities in the event of occurrence of fire. The same may be coupled with suitable extinguishing system such as foam flooding system for extinguishing the fire.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
8.10.2 Smoke Detectors shall be installed in the control room of pump station building, cable trenches in electrical substation and cable cellar to initiate alarm in case of detection of smoke.

8.10.3 Conventional break glass type fire alarm system shall be installed at all strategic locations of the stations and shall be integrated to the Fire Alarm Panel in the pipeline control room and the same shall be extended to the marketing control room in delivery / terminal stations. Manual call point with talk back facilities should be installed in the strategic locations of large size tank farm and to be hooked up with station fire alarm panel.

8.10.4 Clean Agent (Halon substitute) based flooding system may be considered for control rooms, computer rooms of pump station, terminal station, delivery / tap off stations.

8.10.5 Fire water network with fire hydrants, long range monitors and fire water storage shall be provided at all stations except scrapper stations and sectionalizing valve stations inline with para 13.0 of this standard.

9.0 MATERIALS

9.1 General

9.1.1 Materials for use in the pipeline system shall comply with the design and service requirements and shall be suitable for the intended fabrication and / or construction methods.

9.1.2 Materials to be used in facilities exposed to low ambient and / or low operating temperature shall have adequate impact properties to prevent brittle fracture at such low temperatures.

9.2 Steel Pipe

Carbon Steel line pipe for use in liquid pipeline system shall be Seamless, Electric Welded (EW) or Longitudinal / Helical Submerged Arc Welded (LSAW/HSAW) conforming to Line pipe Specification API 5L Product Specification Level (PSL) - 2 or equivalent.

9.2.1 Pipes made of cast iron shall not be used in sour multiphase service. Use of ductile iron pipes is not permitted for liquid hydrocarbon pipelines.

9.2.2 Electric welded pipes manufactured to API specification 5L shall also meet additional requirements specified under Annexure-V of this standard.

9.2.3 Carbon Equivalent

The maximum limits on Carbon Equivalent (CE) for Steel line pipes shall be as follows:

\[
CE (Pcm) = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B
\]

\[
CE (IIW) = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}
\]

For carbon content less than or equal to 0.12%

For carbon content more than 0.12%

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
9.2.4 Ultrasonic testing shall be carried out for 100% of the pipe weld seam. Ultrasonic testing for pipe ends shall be mandatory.

9.2.5 **Mill Hydrotest**
Line pipes are recommended to be hydrostatically tested in pipe mill using test pressure that produces a hoop stress equal to 95% of SMYS irrespective of grade of pipe material. The pressure shall be held for a minimum period of 15 sec.

9.2.6 **Fracture Toughness**
Carbon steel line pipes shall meet the fracture toughness requirements stipulated in ASME B 31.4

9.2.7 **Notch Toughness Requirements**
For carbon steel pipes and other steel components of size NPS 2 and larger, notch toughness values shall be determined to provide protection against fracture initiation and propagation. Notch toughness values (minimum impact absorbed energy values) shall be specified based on the design operating stress and the minimum design temperature.

For carbon steel pipes and other components smaller than NPS 2 proven notch toughness properties are not mandatory.

9.3 **MATERIALS FOR SOUR MULTIPHASE SERVICE**

9.3.1 **NACE Standard MR-01-75** 'Sulphide Stress Corrosion Cracking Resistant Metallic Materials for Oil Field Equipment defines limiting concentrations on hydrogen sulphide in the fluid transported' for it to be considered as sour service.

**Note:**
While past experience has indicated this to be the accepted minimum concentration at which sulphide stress corrosion cracking may occur, the presence of other constituents in the phases making up the multiphase fluid, such as carbon dioxide in the gas and salt in the water or larger amounts of free water or gas, may cause problems to occur at lower concentrations of hydrogen sulphide.

9.3.2 **General**
In addition to the applicable requirements of B31.4 and this standard, all materials used in sour multiphase service shall meet the following requirements.

a) Pipe, valve, fittings, flanges bolting and other equipment exposed to or which are necessary to contain sour multiphase fluids may be susceptible to stress corrosion cracking and hydrogen induced stepwise cracking and thus due consideration shall be given to material selection in design.

b) Materials for sour multiphase service shall conform to the requirements of NACE Standard MR-01-75, 'Sulphide Stress Corrosion Cracking Resistant Metallic Material for Oil Field Equipment'. Depending upon the service and the materials involved, the additional tests for Sulphide Stress Corrosion Cracking (SSCC) and Hydrogen Induced Cracking (HIC) as specified in NACE standards MR-01-75 and TM-02-84 respectively, should also be conducted for long & short term behaviour of material under corrosive environments.

c) Pressure containing components (excluding pipe) intended for sour multiphase service shall be fully identified with a permanent marking.

9.4 Pipes and fittings manufactured to standards listed in Annexure – VI of this standard should be used.

10.0 **Corrosion Control**

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
10.1 General

10.1.1 All above ground and buried pipelines shall be adequately protected against external corrosion.

10.1.2 Above ground pipes shall be protected from atmospheric corrosion by suitable coating or paint.

10.1.3 Above ground sections of pipelines on which MOVs or instrumentation transducers / transmitters or other electrical devices are installed shall be electrically isolated from the buried pipeline sections. This requirement, however, need not be applied to above ground pipeline section on suspension and / or bridge crossings.

10.1.4 Buried section of pipeline likely to be affected by external corrosion shall be protected by combination of anticorrosion coatings and cathodic protection (CP).

10.1.5 For station piping, depending upon the requirement, underground piping shall be protected by anti-corrosion coating and / or cathodic protection system.

10.1.6 Wherever insulating devices are installed to provide electrical isolation of pipeline to facilitate the application of corrosion control, these shall be installed above ground. If station CP is not provided pipe surface on each side of the isolating joint should be protected from contact with soil for a length of 2 to 5 meter of the pipe to prevent concentrated flow of current from section to section around the pipeline.

10.1.7 Insulating joints shall be installed at each entry & exit of pipeline stations (pump, delivery, scraper & terminal stations). This insulating joints may be located as the first fitting at the entry point and as the last fitting at the exit point of the station piping.

10.1.8 Insulating joints shall also be installed at the following locations.
   (a) Where pipeline/ structure changes ownership such as metering station, well heads etc.
   (b) Connecting point of two pipelines / structures having different external coating / CP.
   (c) Junction of branch lines having dissimilar metal.

10.1.9 Insulating joints shall be protected by using electrical earthing through sacrificial Zn anodes and surge diverters at such location where pipeline / structure voltage due to electrical power system or lightening is likely to exceed safe limits.

10.1.10 At the pipeline crossing location, carrier pipe shall be installed so that the below grade or submerged portions are not in electrical contact with any casing, foreign piping system or other metallic structures. This shall not prelude the use of electrical bonds where necessary.

10.2 External coating for buried pipeline

10.2.1 Functional requirement
Anticorrosion coating shall be selected duly considering the varying ground conditions found during soil resistivity and soil Microbial, Ionic loading survey carried out along the pipeline route. Selected coating shall meet the following functional requirement:
   (a) Provide electrical isolation between the external surface of the pipeline and environment.
   (b) Have sufficient adhesion to pipe surface to effectively resist under film ingress/ migration of moisture.
   (c) Have sufficient ductility to prevent cracking during field bending and to have a suitable repair methodology for field repair, if required after bending.
   (d) Have adequate mechanical properties to resist damage during handling, laying and operational stresses and have a suitable repair methodology for field repair.
   (e) Suitable for the pipeline operating temperature range.
   (f) Compatibility with Cathodic Protection System.

10.2.2 Coating Specification
Specification for anticorrosion coating shall specify, as a minimum, the following requirements:
   (a) Type of the coating system;
   (b) Minimum coating thickness (in case of multilayer coating, thickness of each layer should be specified).

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
10.2.3 For carbon steel pipelines or mains of NPS 2 and above, 3 layer Polyethylene / Polypropylene or Fusion Bonded Epoxy coating is recommended. Minimum coating thickness for 3 layer Polyethylene / Polypropylene coating on pipe shall be 2.5 mm and on girth weld to be 2.0 mm. Minimum coating thickness for single layer FBE coating shall be 450 micron (0.45 mm) and shall be 700 micron (0.7 mm) for double layer FBE.

10.2.4 All buried bend and fittings shall be coated with Heat Shrink Sleeves or cold applied tape or two pack high build epoxy coating or 100% solids polyurethane coating compatible with mainline coating with minimum DFT 450 microns (0.45 mm).

10.2.5 Field Joint Coating
The field joints shall be protected with a coating material that is compatible with a line pipe coating material. The coating shall be such that it can be easily applied in field conditions. The coating shall be carried out with heat shrink wrap around sleeves or cold applied tape or epoxy or 100% solids polyurethane or any other suitable type of field coating compatible with mainline coating.

10.3 Cathodic Protection system:
10.3.1 In addition to anticorrosion coating, buried pipelines shall also be provided with permanent cathodic protection system. CP system shall be designed in accordance with NACE-SP-0169.

10.3.2 In case, permanent cathodic protection system is not likely to be available within six (6) month from the start of pipeline laying, sacrificial anode based Temporary Cathodic Protection (TCP) system shall be provided till commissioning of permanent cathodic protection system.

10.3.3 Permanent Cathodic Protection system i.e. sacrificial anode or impressed current shall be brought into operation as soon as possible following pipeline construction.

10.3.4 When Impressed Current Cathodic Protection (ICCP) system is used, continuous power supply to the ICCP system shall be ensured by suitable back up power availability and maintained. All CPTRU stations shall be provided with current interrupter devices to facilitate ON / OFF PSP survey.

10.3.5 Test Lead Points (TLPs) shall be installed at the following locations. Distance between two consecutive TLPS shall not exceed 1.0 (one) km. In inhabited areas. In uninhabited areas, however, the distance may be increased to 1.5 (one and half) km.
(a) Both sides of the cased crossing in case width of case crossing is more than 20 m.
(b) Both sides of the river / canal crossing in case the width is more than 50m.
(c) Crossing of two or more pipelines.
(d) At isolating joints with facilities for measurement of details for both sides of the isolating joints.
(e) At sectionizing valve station.
(f) Bridge crossing.
(g) At close vicinity of foreign pipeline anode ground bed
(h) At location where pipeline is connected to earth electrode, galvanic anode for CP and corrosion coupons.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
10.3.6 Pipelines running parallel in common right of way should not be bonded underground in the absence of any overriding considerations. Location of underground bonding connections should be properly identified. Current regulating device (resistor) for proper distribution of current at the current feeding point / bonding point should be provided to maintain equi-potential level for all pipelines in the same ROW thus ensuring no net flow of protective current from one to other co-existing pipelines.

10.3.7 Test leads should be attached to the pipe by Thermit welding or other low heat methods such as pin brazing etc. Brazing / electric welding of test leads on to pipeline is not permitted. However, for charged pipeline, only pin brazing shall be used for cable to pipe connection. During TLP installation on pressurized pipelines or mains, precautions shall be taken to avoid possible failure of the pipeline or mains due to loss of material strength at the elevated welding temperature.

10.3.8 Test Lead attachments to the pipeline shall be completed before taking up hydrotesting of the pipeline section. It is recommended that TLP wire connection to the pipe shall be completed as soon the pipe is lowered in trench and corresponding pipe no shall be noted. Since pipeline chainage are determined after pipe book compilation, this pipe no. noted for the TLP would facilitate to assigned correct pipeline chainage marking of the TLPs subsequently. In fact these TLP chainages can be utilized as proper reference to correctly marked and locate all the Km post on the pipeline RoU / Row.

10.4 Electrical Interference Mitigation
After installation of Permanent CP system, a Electrical interference survey shall be carried out to locate any potential interference current pick-up and discharge location on the pipeline so that adequate interference mitigative measures could be installed accordingly for the pipeline.

10.4.1 Pipelines installed parallel to / near cathodically protected existing foreign pipeline, overhead AC electric transmission line or DC Rail traction or adjacent to a switching yard shall be protected against induced stray current. Protective measures such as metallic bonding, increased protection current, supplementary coating, electrical isolation, galvanic anodes, De-coupling devices such as Polarization cell or any other suitable method may be adopted for such interference mitigation.

10.4.2 Safety devices in line with NACE-SP-0177 shall be installed to prevent damage to the pipeline cathodic protection system due to lightning or fault currents when the pipeline is installed near electric transmission tower footings, ground cables etc.

10.4.3 While laying pipeline near HT power lines, care should be exercised during construction to minimize possible effects of induced alternating current potentials arising out of capacity couplings.

10.4.4 The anode beds should be located remote to pipeline such that there is minimum interference of anode potential gradient zone with the existing underground metallic structures. Location of anode beds shall be physically identifiable at the field and also properly marked on the as-built drawing. Adequacy of remoteness of anode bed to be calculated and included in the cathodic protection design.

10.4.5 Fault current resulting from lightning or fault conditions of electrical facilities could result in serious damage to coating and pipe wall and endanger personnel. These adverse effects may occur where a pipeline or main is close to the grounding facilities of electrical transmission line structures, substations, generating stations or other facilities that have high short circuit current carrying grounding network.

10.4.6 Electrical Bonding across points shall be installed wherever pipelines and mains are to be separated. This bonding shall be maintained when the pipeline and main is separated as shown in the Annexure- VII.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
10.4.7 It is not required to provide additional shorting link across any metallic flange joint. However, it shall be ensured to maintain electrical continuity, before opening of any flange joint. Before opening of the flange joint, a flexible cable shall be connected across the flange by connecting at any two points on the succeeding & preceding section of the flange being opened (either through crocodile clips or fixing the wire with the bolts of any flange succeeding & preceding section of the flange being opened) for avoiding any electrical spark generation during opening of the flange (Refer Figure-2 of Annexure –VII).

10.4.8 After installation of electrical interference mitigation measures, interference survey shall be carried out again to determine the effectiveness of the measures.

10.5 Cathodically Protected pipeline system temporarily out of services. Cathodic protection system shall be maintained on any underground pipeline due to feeder electric system being down / main temporarily out of service. Alternate power source to ensure continuance of cathodic protection or an alternate temporary sacrificial anode based cathodic protection is acceptable provided it ensures adequate protection to the pipeline.

10.6 All Sectionalizing Valve and Motor Operated Valve to be earthed through sacrificial Zn anodes of minimum 20 Kg to ensure no loss of protective current due to these least resistant paths on earthin.

10.7 Post Commissioning coating surveys shall be carried out on underground pipeline preferably one (1) month after the commissioning of Impressed Current Cathodic Protection system, during which period it will be ensured that soil around pipe compacts sufficiently. Following surveys are recommended:

a. Close Interval Computerized ["On" & "Off"] Potential Logging (CIPL) @ every 1m of pipeline ROW.

b. Pearson Survey along pipeline ROW.

c. CAT (Current Attenuation Test) Survey @ every 50m of pipeline ROW.

d. DCGV (Direct Current Voltage Gradient) Survey at defect locations indicated by Pearson, CIPL, CAT surveys.

e. Coating conductance survey at CP Stations and midway between CP stations.

f. Casing & Carrier short surveys.

The above survey results will serve as Reference for future Monitoring comparison of Protection adequacy evaluations/system adequacy audit. This as per NACE External Corrosion Direct Assessment [ECDA] requirement.

10.8 Records of original surveys and Cathodic Protection Design Documents as well as any subsequent modifications to be preserved and made available for future protection adequacy monitoring comparisons/audits.

11.0 CONSTRUCTION

11.1 General

11.1.1 New construction and replacements / repair of existing pipeline shall be accordance with the requirement of this Section. It is not intended herein that all construction items be covered in full detail, whether covered specifically or not, all construction and material shall be in accordance with good engineering, safety and proven pipeline practice.

11.1.2 Pipelines shall be buried below ground level, unless construction above ground is found to be desirable for exceptional technical, economic or topographical reasons. Construction plan should be prepared before commencement of construction to assist in control of the work. The plan shall cover description of the construction methodology; the health, safety and environment plan; inspection and quality requirements, personnel and equipment required, and installation / testing procedures.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
11.1.3 Existing facilities, such as roads, railways, rivers, canals, footpaths, pipelines, cables and buildings likely to be affected by the construction of the pipeline shall be identified prior to the beginning of pipeline laying work and safety measures necessary to protect the existing facilities during construction shall be implemented.

11.1.4 Appropriate guidelines / measures provided in OISD-GDN-192 and OISD-STD-147 related to safety during construction should be implemented.

11.2 Surveying and Right of Way (ROW) / Right of User (ROU).

11.2.1 Laying of cross country pipeline shall be planned along a pre identified surveyed route within a specific width of ROW/ROU for which Right of User has been established under P&MP Act 1962 or obtained thru agreements or permissions.

11.2.2 Width of ROW / ROU shall be decided based on construction methodology, depth of laying, type of construction, equipment proposed, diameter of pipeline and provision of future pipeline. The Land for Cathodic Protection remote ground bed installation and Anode header cable laying from Anode bed to Power source may be included in ROU / ROW requirement.

11.2.3 Detailed Engineering Survey including soil investigation and soil resistivity shall be undertaken for marking alignment on ground and ascertaining of engineering details with crossing alignment and ground profile. Alignment shall be finalized after thorough reconnaissance survey of all feasible alternate routes. In order to ensure adequate safety to public, wherever practicable, pipeline should avoid passing through stone quarries, populated areas, city limits, built up areas having human activities, reserve forests and national park etc. Final route shall be selected considering the followings:
   (i) Easy approachability, ease of construction, operation and maintenance.
   (ii) Protection of environment, other properties and facilities
   (iii) Minimum electrical interference.
   (iv) Avoidance of perennially marshy and water logged area.
   (v) Avoidance of existing and potential mining areas.
   (vi) Population density.

11.2.4 Soil Stratification Survey

Soil Investigation shall be carried out in order to obtain the visual engineering classification of soil along the pipeline route. Visual classification of the soil shall be in accordance with IS 1498. Boreholes for soil samples shall preferably be made at intervals of 500 m along the pipeline route, at all intermediate points where there is apparently a change in the type of soil and at any other place as necessary. For Canal, stream and river crossings, boreholes should be made on either bank and one on the bed. Soil / Water Microbial & Ionic loading to be included in these investigations along pipeline ROU / ROW.

11.3 Location

11.3.1 The location of a new buried pipeline, when running parallel to an existing buried pipeline, shall be at a minimum clear distance of 5.0 meter from the existing buried pipeline when heavy conventional construction equipment is expected to be utilized. This distance may be reduced after careful assessment of construction methodologies so that it does not result in unsafe conditions during construction. In any case the minimum clear distance shall not be less than 3.0 meter. These areas shall be distinctly identified on ground during construction. Where ever caution signs are installed, these shall be in bi lingual (local language and Hindi / English).

11.3.2 No pipeline shall be located within 15.0 metres of any private dwelling or any industrial building or place of public assembly in which persons work, congregate or assemble, unless it is provided with at least 300 mm of cover in addition to that provided in para 11.5 below or other mitigation measures provided like higher pipe wall thickness / protection with RCC slab.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
11.3.3 No blasting activities are allowed within 15 meters of location of the underground pipeline. However, control blasting may be allowed after witnessing appropriate trial blasting and approval from competent authority and pipeline owning company.

11.3.4 When laying more than one new pipeline in the same trench, a minimum clear horizontal separation distance of 500 mm shall be maintained.

11.3.5 In case the pipeline is to be laid parallel to roads/highways, effort shall be made to locate the pipeline outside the limits of highway right of way. Pipelines located within 5 m from the road/highway right of way, shall be provided with higher wall thickness using design factor of 0.6. Also due consideration shall be paid in increasing the pipeline burial depth.

11.4 Excavation
11.4.1 In cultivable land and other specifically designated areas, the top 300 mm soil excavated from the pipeline trench shall be stored separately. This top soil shall be replaced in original position after backfilling and compacting of the rest of the trench.

11.4.2 The width of trench shall be such that a minimum clear distance of 200 mm for trench in normal soil and 300mm for trench in rock is maintained between edge of pipe and the trench wall at the bottom of trench.

11.4.3 In case OFC to be laid in same pipeline trench, clear horizontal distance between pipe and the OFC cable shall not be less than 300 mm.

11.5 Pipeline Cover
11.5.1 All liquid hydrocarbon pipelines shall be buried below the ground level in line with the “Minimum Cover for Buried Pipelines”, as specified in Table-5. Below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Location</th>
<th>Minimum Cover (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Industrial, commercial, residential, cultivated, agricultural and barren areas</td>
<td>1.2 (For normal soil) 1.0 (For rocky strata)</td>
</tr>
<tr>
<td>2.0</td>
<td>Minor water crossing/ canal/ drain/ nala</td>
<td>1.5 (For normal soil) 1.0 (For rocky strata)</td>
</tr>
<tr>
<td>3.0</td>
<td>HDD crossing rivers (below scour depth)</td>
<td>2.5</td>
</tr>
<tr>
<td>4.0</td>
<td>HDD crossing at Canals (below bed)</td>
<td>4.0</td>
</tr>
<tr>
<td>5.0</td>
<td>River crossings (below scour) –open cut</td>
<td>2.5 (For normal soil) 1.0 (For rocky strata)</td>
</tr>
<tr>
<td>6.0</td>
<td>Cased/uncased road crossing/ Station approach</td>
<td>1.2</td>
</tr>
<tr>
<td>7.0</td>
<td>Railway crossing</td>
<td>1.7</td>
</tr>
<tr>
<td>8.0</td>
<td>Marshy land/ Creek area</td>
<td>1.5</td>
</tr>
</tbody>
</table>

NOTES:

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
i. The depth of cover shall be measured from the top of the pipe coating to the top of the undisturbed surface of soil or the top of graded strip, whichever is lower.

ii. The cover shall be measured from the top of road or top of rail, as the case may be;

iii. For river/watercourses that are prone to scour and / or erosion, the specified cover shall be measured from the expected lowest bed profile after scouring / erosion. When scour level is not known, an additional cover of at least 1 m (over and above the cover mentioned in Table.5) shall be provided from the existing bed of the river/water course except in case of rocky river bed;

iv. Whenever the above provisions of cover cannot be provided due to site constraints, additional protection in form of casings, bridging, etc shall be provided.

v. When insisted by authorities, the depth shall be maintained as per the direction of concerned authorities.

11.5.2 In rocky areas and areas with hard soils / gravels, minimum 150 mm thick padding of soft soil / sand shall be provided all around the pipe. Protective layer of rock-shield / rock guard may be provided in addition to soft padding to prevent damage to coating / steel pipe during installation.

11.5.3 No dwelling or permanent structure in any form shall be permitted within the Right of Way (RoW) or Right of User (RoU).

11.5.4 In case the pipeline is to be laid through populated area (which otherwise could not be avoided), additional protective measures to be provided by way of laying at a greater depth or providing higher wall thickness pipe compare to normal terrain. In high consequential area it is recommended that maximum operating pressure of the pipeline does not exceed more than 40% of SMYS of pipe.

11.6 Cold field bends

11.6.1 The radius of cold field bends shall be as specified in para 5.7.

11.6.2 Bends shall be checked by pulling a gauging pig fitted with gauging plate of diameter equal to 95 percent(%) of the nominal internal diameter of the pipe. The pig shall have at least two cups not less than 300mm apart or pipe nominal diameter whichever is larger.

11.6.3 Pipes with longitudinal welds shall be bend in such a way that weld lies in or near the plane passing through neutral axis of the bend. As far as possible, the bend should be installed such that longitudinal weld lies in the upper quadrants between 10’O’ clock and 2 ‘O’ clock position.

11.6.4 External Corrosion protection coating shall be visually examined after bending and holiday tested for defects. Any defects or disbonding of the coating caused during bending (including forced ridges in the coating) shall be repaired.

11.6.5 Factory Made Bends, Elbows and Tees

Factory made bends, elbows and tees may be used. Such fittings shall have similar mechanical properties and chemical composition as the pipe to which they are welded. If factory made elbows are used in cross country lines, care should be taken to allow for passage of pigs and instruments for internal inspection of pipes.

11.7 CROSSINGS.

11.7.1 General

11.7.1.1 As far as practicable, pipeline should cross existing facilities at right angles. Turning Points (TPs) provided on either side of crossing should be located at least 50 m from the boundary of
the crossings, except for the stretches which runs parallel to road. Minimum cover shall be as per para 11.5.

11.7.1.2 Use of casings for crossings shall be avoided unless required by the authorities having jurisdiction over the facility being crossed.

11.7.1.3 When road / highway / rail crossing is installed using a casing pipe, minimum diameter, thickness and length of casing pipe shall comply with API RP-1102 and other statutory norms.

11.7.1.4 Carrier pipe / casing pipe may be installed by open cut, boring, jacking or other suitable trenchless techniques.

11.7.1.5 For Horizontal Directional Drilling (HDD) crossings and cased crossings, 3 layer polyethylene / poly propylene or equivalent coating should be used for the carrier pipe.

11.7.1.6 All girth weld joints of the section of the carrier pipe to be used for the crossing shall be non-destructively tested over their entire circumference by 100% radiographic inspection, ultrasonic testing, magnetic particle testing or a combination of these besides other equivalent comparable method.

11.7.1.7 Carrier pipe shall be adequately separated inside casing pipe using casing insulator made of durable and electrically non-conductive materials. The inter distance between centre to centre of any insulator should not be more than 1 meter. One additional casing insulator shall be provided on each end of the casing pipe.

11.7.1.8 The section of the carrier pipe corresponding to the cased crossing shall be subjected to hydrostatic pre testing. Post installation hydro testing shall be done with mainline hydrotesting.

11.7.1.9 Casing end seals shall be installed to prevent ingress of water and / or foreign material into casing. Vent and drains shall be provided near both ends of the casing pipe.

11.7.1.10 A mixture of sand + Bentonite may be filled in the casing carrier annulus as a measure to prevent moisture ingress.

11.7.2 Road / Highway / Railway Crossings
The angle of crossings shall be as close to 90 degrees as possible. Installation of carrier pipe at road / highway crossings without casing shall be checked for allowable stresses in accordance with API RP-1102.

11.7.3 Water Crossings
Crossings should be located in a comparatively straight reach of the river, where the banks are stable, minimum evidence of erosion of bed, sufficient area for construction is available. Angle of crossing shall be as close to 90° as possible.

Special considerations shall be required for river crossings which are characterized by their perennial nature, meandering course, steep and potentially erodible banks, potentially scouring bed, large erodible flood plain and wide water course (high flood level) both during the design and installation of such crossings.

For river crossings such as those described and established above the following additional requirements are to be considered.

a) Hydrological and geotechnical surveys to establish the river bed and water current profiles to predict the behaviour of the river with respect to change of course, scour of bed and erosion of banks and to obtain all other parameters related to design and installation of such crossings.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
b) To ensure the stability of the underwater pipeline, it may be necessary to add weight to sink and hold the pipeline in position.

c) A heavier wall thickness pipe should be provided for the river crossing section.

d) A detailed stress analysis for the pipe section for river crossings shall be carried out for Directionally Drilled Crossings, taking into consideration the effect of all loads during laying and it shall be ensured that the stresses remain within permissible limits in accordance with B 31.4.

e) In case of horizontal directional drilling, plan for containment and disposal of drilling fluids, shall be developed.

f) Hydrostatic test plan that should consider pre testing of the fabricated string(s) prior to installing the crossing.

g) For HDD crossing pre and post (installation) hydro testing of the pipe string shall be carried out.

11.7.4 Crossing of Utilities

11.7.4.1 When a buried pipeline has to cross any existing underground pipeline, cable, drain or other services, the pipeline shall be laid at least 500 mm below such existing utility / services in a manner that will not obstruct access to such services for inspection, repair, or maintenance. Where it is not practicable to obtain the above mentioned clearance, special design and construction shall be used. A minimum 6mm thick and 5 meter width, Non Toxic Rodent Resistant PVC sheet will be continually installed between cable and pipe as a measure of preventing fault current accessing pipeline. A warning sign board (above) ground shall be installed on the RoU / RoW to indicate HT cable crossing.

11.7.4.2 When laid parallel to, along or near existing underground HT power cable underground pipes should maintain a horizontal clearance of 5 m. Wherever this distance cannot be met, a minimum 6mm thick and 5 meter width, Non Toxic Rodent Resistant PVC sheet be continually installed between cable and pipe as a measure of preventing fault current accessing pipeline. In any case this horizontal distance shall not be less than 3m.

11.7.4.3 In case of existing communication cables, conductors or conduit, underground pipes shall maintain a vertical clearance of at least 500 mm and horizontal clearance of 500 mm. Where these clearances cannot be maintained, extra precaution shall be taken to ensure the maximum possible clearance and to prevent future contact.

11.7.4.4 A minimum separation of 3.0 meter should be maintained between pipeline and transmission tower footings.

11.7.4.5 Interference with, or from, other systems through the application of cathodic protection shall be dealt by mutual action of the parties involved.

11.8 Handling, Hauling, stringing and storing
Pipe shall not be strung along the right of way in rocky areas where blasting may be required, until all blasting is complete and the area cleared of all debris. Material other than line pipe shall not be strung on the right of way but shall be transported to site for use only at the time of installation. Transportation shall be performed in such way as to avoid damage to the pipe and pre applied coatings.

11.9 Tie-In

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Gaps left in the continuous line construction at such points as river, canal, highway, or railroad crossings require special consideration for alignment and welding. Sufficient equipment shall be available and care exercised not to force or strain the pipe to proper alignment.

11.10 Welding and Inspection Acceptance Criteria

11.10.1 Welding

11.10.1.1 All welding shall be in accordance with ASME B 31.4.

11.10.1.2 Welding procedures and welders shall be qualified as per API 1104; however, welding procedures and welders, for station piping shall be qualified as per sections V and IX of the ASME Boiler and Pressure Vessel Code. Welder re-qualification shall be required if the welder has not performed any welding for the welding process qualified for the past 6 months. The welding procedure followed during the qualifying tests shall be recorded in detail.

11.10.1.3 The weld joints shall be numbered and marked along with the welder identification, adjacent to the weld joint on the progressive direction of main line.

11.10.1.4 No cut piece of mainline pipe of length less than two (2) meter shall be used in the pipeline. It shall be ensured that there shall not be more than three (3) circumferential welds in eight meters of straight run buried pipeline for pipe size NB 6 and above. Cut pipes shall have details of pipe reference numbers painted to the inside of each pipe end.

11.10.1.5 Safe Practices in Cutting and Welding

Prior to cutting and welding in areas in which the possible leakage or presence of vapour or flammable liquid constitutes a hazard of fire or explosion, a thorough check shall be made to determine the presence of a combustible gas mixture or flammable liquid. Cutting and welding work shall begin only when safe conditions are indicated and a valid hot work permit as per OISD-STD-105 is issued by Authorised person.

11.10.2 Welding Inspection

11.10.2.1 All NDT (non-destructive testing) including Radiographic examination and destructive method of examination shall be performed in accordance with the requirements of API 1104 / ASME section IX of B&PV Code.

11.10.2.2 The quality of each weld shall be examined by visual inspection. Regardless of operating hoop stress all carbon steel butt welds in liquid hydrocarbon pipelines shall be subjected to minimum 20% radiographic examination and/or ultrasonic testing of girth welds (completely around pipe circumference) completed each day randomly selected by pipeline operating company. The weld joints in vent and drain piping open to atmospheric pressure need not be radiographed/ultrasonically tested. Such welds however shall be visually examined and 20% of such welds shall be examined by liquid penetrant testing.

11.10.2.3 100% of welds in liquid hydrocarbon piping in pump station and other pipeline stations shall be non-destructively tested over their entire circumference by radiographic examination or ultrasonic testing. In addition each weld shall be visually examined for quality of weld.

11.10.2.4 100% inspection by radiography of the weld joints shall be carried out at the location of residential and industrial areas, river, lake, stream crossings (submerged or bridge crossings), rail, road, overhead rail / road crossings, offshore and inland coastal waters and tie-ins etc.

11.10.2.5 All butt welded golden joints (i.e. welds joints which are not subjected to pressure testing) shall be subjected to 100% radiography and/or examination by ultrasonic techniques. Socket

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
welded joints shall be tested by using Liquid Penetrant Inspection (LPI) method or wet Magnetic Particle Inspection (MPI) method.

11.10.2.6 Weld repair areas shall be subjected to additional radiography or ultrasonic testing after repair. Repair welders shall be qualified inline with para 11.10.2.1.

11.11 COATING INSPECTION DURING CONSTRUCTION

11.11.1 Field pipeline coating shall be applied on a properly prepared surface and visually inspected during application. Any cutting or removal of the coating shall be promptly and carefully repaired after proper surface preparation.

11.11.2 Finished coating shall be subjected to visual & full circle holiday detection for punctures, pinholes, external appearance, air entrapments, dimples & wrinkles. The Holiday Detector shall be set to DC voltage of 5 KV/ mm of coating thickness & it shall be calibrated every day before commencement of inspection. In any case DC voltage shall not be less than 3 KV.

11.11.3 One out of every 200 finished joint coatings or one of the every day's productions, whichever is less, shall be subjected to peel test by peeling-off a strip of size 25mm x 200 mm, at three locations which shall be as under:

(i) Perpendicular to pipe axis.
(ii) Over the weld seam (girth/seam).
(iii) Over the overlap portion of the pipe coating.
(iv) The system should not fail in any adhesive layer.

11.11.4 Additional precautions such as double coating, rock shield, warning nontoxic rodent resistant PE mats having "Pipeline Below" inscribed and selected backfill, and ditch padding shall be taken where conditions are such that damage to the pipe coating could occur.

11.11 DENTS
Pipe shall be inspected before coating and before assembly into the mainline or manifolding. Distortion, buckling, denting, flattening, gouging, grooves, or notches, and all defects of this nature, shall be prevented, repaired, or eliminated as specified herein.

11.12.1 All dents that affect the curvature of the pipeline at the longitudinal weld or circumferential weld shall be removed. The depth of dent shall be measured as the gap between the lowest point of the dent and the original contour of the pipe. The maximum permissible depth of dents in pipes up to and including 12.75" inch (324 mm) nominal outside diameter shall be 5 mm. For pipes over 12.75" inch (324 mm) nominal outside diameter, the permissible depth of dent shall be 2 percent of the nominal pipe diameter. Length of the dent in any direction shall not be more than one-fourth of nominal diameter of the pipe. Dents beyond permissible limit shall be removed by cutting out the damaged portion of the pipe as cylinder and replacing with a pre tested pipe.

11.12.2 All dents as mentioned in para 11.12.1 and a dent containing a stress concentrator, such as a scratch, gouge, groove, or arc burn, shall be removed by cutting out the damaged portion of the pipeline as a cylinder and replacing with a pre tested pipe section. Buckled pipe shall also be replaced as a cylinder.

11.12.3 Distorted or flattened lengths shall be discarded.

11.13 LOWERING

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
11.13.1 Before lowering operations are commenced, particular attention shall be paid to the suitability of the trench to allow the pipeline to be lowered without the coating being damaged and to give a reasonably even support to the pipeline.

11.13.2 Before lowering, a complete check by a full circle holiday detector set at an appropriate voltage shall be carried out. All coating defects and damages identified by holiday detection shall be repaired.

11.13.3 **Installation of Pipe in the Ditch**
It is very important that stresses induced into the pipeline during construction be minimized. The pipe shall fit the ditch without the use of external force to hold it in place until the backfill is completed. When the pipe is lowered into the ditch, care shall be exercised so as not to impose undue stress in the pipe. Slack loops may be used where laying conditions render their use advisable.

11.14 **BACKFILLING**

11.14.1 Backfilling shall be carried out immediately after the pipeline has been laid in the trench. In cultivable land and other specifically designated areas, top soil excavated from the trench of the Right-of-Use shall be stored separately and shall be restored to normal condition. The backfill material shall contain no extraneous material and/or hard lumps of soil, which could damage the pipe and/or coating or leave voids in the backfilled trench. Where the ditch is flooded, care shall be exercised so that the pipe is not floated from the bottom of the ditch prior to backfill completion.

11.14.2 Slope breakers shall be installed in trenches in steep areas (slope of generally 10 degree and more) for the purpose of preventing erosion of the back fill. When backfilling the trenches in sloping terrains or steep areas, wherein the chances of wash out of backfill exist, sheet piling or other effective water breakers across the trench shall be provided.

11.15 **PIPELINE MARKERS**

11.15.1 Following type of markers shall be installed along the pipeline in ROU / ROW:

a) Kilometre markers.
b) ROU boundary Pillars.
c) Direction/Turning Point (TP) markers.
d) Warning signs.

11.15.2 **Kilometre Markers**
Kilometre Posts shall be installed at every kilometre point at nearest boundary of plots and its distance from reference / originating point shall be properly painted on it. Markers shall also be installed on each side of Major District Road (MDR), highways, railway crossing, water crossings. The installation of kilometre post shall be carried out after completion of hydrostatic testing, compilation of pipe book and cleanup and restoration of ROU.

11.15.3 **Boundary Pillars**
Boundary pillars made of concrete and fabricated, painted indicating name of pipeline owing company shall be installed on either side limits of ROU at every 250 meters at nearest boundary of plots. In addition, the boundary pillars shall also be installed on either side limits of ROU at major rail/road/river crossings.

11.15.4 **Direction/Turning Point Markers**
These markers shall normally be made of 3" dia. pipe with a plate welded at the top indicating the direction of turning. One direction marker shall be installed at each turning point and in
addition two more direction markers shall be installed along the pipeline alignment, one on either side of turning point at a distance of 200 meters from the turning point.

11.15.5 **Warning Signs**
Fabricated Permanent warning signs shall be installed at all important crossing (Rail/Road/River/Canal) locations and at habitations near ROU. Normally one warning sign shall be installed at location having a crossing length of less than 15 m & two warning signs are installed at crossings having length more than 15 m. The warning signs should contain following minimum information in local , Hindi and English languages.

- Name of pipeline and operating company
- "High Pressure Pipelines", Hazardous area .
- Contact telephone numbers in case of emergency situation.

12.0 **TESTING AND COMMISSIONING**

12.1 **Cleaning and Gauging of pipeline**
Before hydrotesting, the section of the pipeline shall be cleaned and checked for geometry of the pipeline. A gauging pig shall be passed through the pipeline to prove the internal diameter of the entire pipeline. The gauging plate shall have a diameter equal to 95% of the minimum internal diameter of the pipeline section. The gauging plate should preferably be made of minimum 10 mm thick aluminium plate and shall have incisions at every 45 degrees.

12.2 **Hydrotesting of Pipeline**

- All Pipelines shall be pressure tested in-place after construction except for pre-tested pipes used in tie-in spools.
- Installation of all electrical connection and monitoring points on the pipelines shall be completed before pressure testing of the pipeline. No welding (other than tie-in welds) and / or mechanical handling of pipe are permitted after pressure testing. Pipe used for making repairs shall be pre-tested to a pressure equal to or greater than the original pipeline strength test pressure.
- Mainline pipe in river crossing sections shall be hydrotested before and after installation at least for 4 hours at 1.25 times the design pressure.
- Carrier pipe in cased crossing (rail / road) section shall be hydrotested before installation at least for 4 hours at 1.25 times the design pressure.
- All such previously tested sections shall be retested along with the completed mainline sections at 1.25 times the design pressure of mainline in line with clause 12.3 of this standard.
- Water used for the test medium shall be dosed with required quantity of corrosion inhibitor and oxygen scavenger depending upon quality of the water.
- API-1110 recommended practice should be used for guidance for the hydrostatic test.

12.3 **Test Pressure and Test Duration- Mainline**

- The minimum test pressure at any point along the pipeline shall be as 1.25 times the internal design pressure.
- The maximum test pressure normally shall not exceed the mill test pressure or pressure required to produce a hoop stress equal to 95 percent of SMYS of the pipe material based on minimum wall thickness in the test section whichever is more.
- The test pressure shall be maintained for a minimum period of twenty four (24) hours except where specifically mentioned.
- Pressure variations during testing shall be acceptable, if caused by factors other than leakage, like temperature variations. Maximum unaccounted pressure variation shall not exceed 0.3 bars. Pipelines not meeting the requirements shall be repaired if necessary and retested in accordance with the requirements of this standard after addressing the reasons for variations.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
e) Mainline valves along with branch pipe should be pressure tested before installation and shall be installed after successful pressure testing of the pipeline.

12.4 Test Pressure and Test Duration- Station Piping
a) Pressure testing of station piping shall be carried out separately from pipeline.
b) Station piping shall be tested at minimum test pressure of 1.25 times the design pressure.
c) The test pressure shall be maintained for a minimum period of four (4) hours.
d) Internal test pressure of low pressure station piping shall be governed by pressure ratings of fittings and valves fitted in the system. Duration of the test shall be not less than 4 hrs.

12.5 Low Pressure Leak Check:
All flanged joints in above ground pipeline / piping, equipment, instrument impulse tubing, etc. Shall be tested by pressurizing the piping system / equipment with dry compressed air / water at a pressure of 3.0 kg/cm²g and checked by means of soap solution / suitable digital gauge for leaks as applicable.

12.5 Dewatering and Drying
After hydrotesting of the pipeline sections / station piping, the section shall be dewatered immediately except when the section is filled with inhibitor. After dewatering, the section shall undergo swabbing.

12.6 Geometric Survey
Survey to establish pipeline geometry using Electronic Geometric Pigs (EGP) shall be conducted after completion and acceptance of following pipeline activities:
- Gauging
- Pressure Testing
- Cleaning and swabbing
- Installation of Mainline / Sectionalizing Valve stations
- All tie-ins

12.7 If the pipeline commissioning after pressure testing is anticipated to be delayed beyond six (6) months, suitable preservation technique shall be adopted to prevent corrosion during such period. Pipeline shall be preserved using adequate quantity of corrosion inhibitors or by filling the pipe line with non-flammable non-toxic gas and at a positive pressure.

12.8 Following records shall be maintained by pipeline owner:-
- Design & Engineering documents.
- Construction inspection reports
- Material certification, performance and functional reports.
- A complete pipe book
- Pressure test records, including location of leaks or failures, if any, and description of repair under taken.
- Leak test reports
- Complete asset of each location with identification.
- As-built drawings including pipeline route maps, alignment sheets, crossings drawings, Piping and Instrumentation Diagrams, station layouts, piping isometric, earthing grid, single line diagrams, instrument and cable layouts, loop diagrams, etc.
- Equipment manuals supplied by manufacturers.
- Approved Vendor drawings.
- NDT records of welds.
- Cleaning and swabbing report
- Geometric survey reports and repairs, if any, carried out.
- Statutory Clearances
- Equipment Manuals
- Calibration records of instruments, measuring, metering and test equipment.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
q. Pre-commissioning Audit compliance report.
r. Details of ROW / Rou Owners, pending court cases pertaining to acquisition of ROW / RoU.

12.9 COMMISSIONING

12.9.1 A proper commissioning procedure shall be prepared for removal of air from the system and to prevent intermixing of air and the hydrocarbons.

12.9.2 Before starting commissioning activities, following shall be ensured:

a) Pressure testing is completed for entire pipeline and associated station piping.
b) Low pressure leak check of the above ground piping / flanged joints completed.
c) Pipeline has been cleaned and ferrous material / debris etc. removed.
d) All mainline / sectionalizing valves are installed as per requirement.
e) All golden joints are inspected and accepted.
f) Geometric survey of pipeline, section is carried out.
g) Temporary modifications required at the stations for commissioning have been completed in all respect.
h) Commissioning check list prepared and ensured availability of all materials, tools, tackles and consumable.
i) Fire fighting facilities are ready.
j) All caution boards displayed.
k) Trained and experience personnel are available / deployed to carry out commissioning.
l) Pre-commissioning safety audit by OISD is completed and compliance submitted.
m) Emergency preparedness plan for the location as well as for off-site(pipeline route) prepared.
n) Site Specific “Standard Operating Procedure (SOP)” duly approved by competent person.

12.9.3 The commissioning operation shall be controlled and supervised by authorized personnel.

12.9.4 Venting shall be controlled at the pig-receiving end so that proper backpressure is maintained to control pig train speed of 3 to 4 km /hr. The desired portion of the pipeline shall be commissioned in this manner. The pipeline system shall subsequently be slowly pressurized up to its operating conditions.

13.0 SAFETY AND FIRE PROTECTION SYSTEM

13.1 General

All installation except Intermediate pigging station and sectionalizing valve stations shall have fire prevention and protection system as under.

13.2 Fire Water System

The Fire water system shall be provided at all pump stations and at all delivery and terminal stations consisting of:

a. Fire water storage
b. Fire water Pumps
c. Fire water distribution piping network
d. Fire hydrant / Monitors

Fire water system shall be designed to combat one major fire anywhere in the installation.

13.2.1 Design Flow Rate

The design fire water flow rate & pumping requirement shall be based on OISD-Std-117.

13.2.2 Fire Water System Design

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
(a) The Fire water pressure system shall be designed for a minimum residual pressure of 7.0 kg/cm²(g) at the hydraulically farthest point of fire water network.
(b) A fire water ring main shall be provided all around perimeter of the pump station and delivery / terminal stations facilities with hydrants / monitors.
(c) There shall be minimum two (2) numbers of monitors located in such a way that it covers the pump area, scrapper area and filter area. Fire hydrant network shall be in closed loops to ensure multidirectional flow in the system. Isolation valves shall be provided where the length of the pipe section is more than 300 mtr.

13.2.3 Fire Water Storage

(i) Water requirement for fire fighting shall be met through water storage tanks of steel or concrete or masonry. The effective capacity of the tanks above the level of suction point shall be as per OISD-Std-117.
(ii) Storage tank / reservoir shall be in two interconnected compartments to facilitate cleaning and repairs. In case of steel tanks there shall be a minimum of two tanks.

13.2.4 Fire Water Pumps

(i) Centrifugal fire water pumps shall be installed to meet the designed fire water flow rate and head. Pump shall have flooded suction.
(ii) Motor driven Jockey pump (not more than 10 M3 / Hr of water flow) may be installed to maintain the fire network pressure at 7.0 Kg/Cm² (g) at farthest end of the network.
(iii) The fire water pumps including the stand by pumps shall preferably be diesel driven. Where electric supply is reliable 50% of the pumps may be motor driven.
(iv) A minimum of 50% stand by pump(s) (minimum one no) of the same type, capacity and head as the main pumps shall be provided.
(v) The fire water pumps shall be provided with automatic starting facilities.

13.2.5 Fire Hydrant Network

(i) Fire water ring main shall be sized for 120% of the design water flow rate. Velocity of the water shall not exceed more than 5 m/s in the fire water ring main.
(ii) Fire water steel pipe ring main shall be laid above ground at a height of 300 mm to 400 mm above finished ground level. Pipes made of composite material shall be laid underground.
(iii) The mains shall be supported at regular intervals not exceeding 6 mtr. For pipeline size less than 150mm diameter, support interval shall not be more than 3 m.
(iv) The steel pipe ring main shall be laid underground at the following places:
   (a) Road crossings
   (b) Where above ground piping is likely to cause obstruction to operation, vehicle movement and likely to get mechanical damage.
   (v) Under ground fire water mains shall have at least 1 mtr earth cushion in open ground and 1.5 mtr under roads with concrete / steel encasement.
   (vi) The underground fire water steel pipe network shall be provided with suitable coating / wrapping or concrete / masonry.
   (vii) Double headed hydrants with two separate landing valves on 3” / 4” stand post shall be used. All hydrant outlets shall be 1.2 mtr above ground level.
   (viii) Fire water monitors shall be provided with independent isolation valves.
   (ix) Hose Box with 2 Nos. of hoses and a nozzle (FB 5X) shall be provided to cater two hydrant points.
   (x) Fire Hydrants/ monitors shall be located at a minimum distance of 15 mtrs from the hazardous facility / equipment. Case of buildings this distance shall not be less than 2 mtr and not more than 15 mtr from the face of building. Provisions of hydrants within the building shall be provided in accordance with IS.3844.
   (xi) At least one hydrant post shall be provided for every 30 mtr of external wall measurement or perimeter of the battery limit. Monitors shall be placed at 45 mtr

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
13.2.6 MATERIAL SPECIFICATIONS
All material used in fire water system using fresh water shall be of the type indicated below:

- Pipes - Carbon Steel (CS) IS: 3589 / IS : 1239 / IS : 1978 or Composite materials as per API 15 LR / API 15 HR or its equivalent shall be used.

In case saline / brackish water / treated effluent water is used, the fire water main of steel pipes shall be, internally cement mortar lined or glass reinforced epoxy coated or made of pipe material suitable for the quality of water. Alternatively, pipes made of composite materials shall be used.

Cast Iron pipes shall not be used for fire water services.

- Isolation valve , Deluge Valve , - Gate / butterfly type isolation valve with open / close indication made of cast steel. Other material such as cupro-nickel for saline / brackish water may be used.
- Hydrant Stand post, Monitors – Carbon Steel / Gunmetal
- Outlet valves/ landing valves- Gunmetal / Aluminum/ Stainless steel / Aluminium-Zink alloy.
- Fire Hose- Reinforced rubber lined hoses (63 mm), 15 mtr std length conforming to IS: 636 / UL 19 (type A) / Non percolating synthetic hose (Type B).
- The above ground fire water main, hydrant post shall be painted with corrosion resistant “fire Red” paint as per IS: 5
- Water monitors, hydrant point and hose box shall be painted “ Luminous Yellow” as per IS: 5

13.2.7 HOSES, NOZZLES AND ACCESSORIES AND SPARES
(i) Hose Box: 1 no. for catering to two hydrant points.
(ii) Fire hoses – 2nos / per hose box – Minimum 10 nos.
(iii) Jet Nozzle: 1 no. in each hose box.
(iv) In addition to the nozzles provided in the hose boxes there shall be 1 set of spare nozzles for each category viz- Jet Nozzle with branch pipes, Fog Nozzle, Universal Nozzle, water curtain Nozzle and spray Nozzle.
(v) Minimum 2 Nos. Or 25% spare hoses shall be stored.

13.3 Detection System
Smoke detectors shall be provided in control room, Motor Control Center (MCC) room and utility rooms with provision of indication, alarm & annunciation.

13.4 Fire Alarm System
a. Manual call point shall be installed at strategic operating areas of pump station, delivery station / terminal stations.

b. Electric operated fire sirens with audible range of 3 km shall be installed. Provision shall be made for continuous availability of power to this system during emergency shut down.

c. Manual operated fire sirens shall be provided at strategic places.

13.5 Fire Fighting Equipment & First Aid
Fire fighting & First Aid equipment as described below shall be installed at all stations.

13.5.1 Portable Fire Extinguishers
a) All fire extinguishers shall conform to respective IS/UL or Equivalent codes, viz. 10 Kg DCP Type (IS:2171/UL 299), 4.5 / 6 / 8 Kg CO₂ Type (IS:2878/UL 154) & 25 / 50 / 75 Kg DCP Type (IS:10658/UL 299) and bear ISI/UL mark. BIS/UL or Equivalent certificates of all extinguishers shall be maintained at the location.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
b) While selecting the Extinguisher, due consideration should be given to the factors like flow rate, discharge time and throw in line with IS:2190 / UL 711.

c) The Dry Chemical Powder used in extinguisher and carbon dioxide gas used as expelling agent shall be as per relevant IS/UL or Equivalent code.

d) While selecting the dry chemical powder, due consideration should be given to the typical properties viz. Apparent Density (0.65 +/- 0.05), Fire Rating (144B), Thermal Gravimetric Analysis (with decomposition at around 250°C) and foam compatibility.

e) Siliconised Potassium bicarbonate DCP powder (IS 4308:2003) / Mono-ammonium phosphate based DCP powder (IS: 14609) can also be used for recharging DCP fire extinguishers.

f) Portable fire extinguishers shall be located at convenient locations and are readily accessible and clearly visible at all times.

g) The sand buckets shall have round bottom with hand handle having 9 litre water capacity conforming to IS:2546. The sand stored in bucket shall be free from oil, water or rubbish.

h) Rain protection of suitable design should be provided for all extinguishers & sand buckets.

i) The maximum running distance to locate an extinguisher shall not exceed 15 m.

j) The extinguisher shall be installed in such a way that its top surface is not be more than 1.5 m above the floor/ground level.

The no. of extinguishers at various locations shall be provided as under.

i. Booster Pump area: 1 (One) No. 10 Kg DCP per two pumps up to a maximum of 3 nos. And 1 (one) No. 6.8 Kg CO₂ extinguisher.

ii. Main line pump shed (Engine/Motor Driven): 1 (one) No. 75 Kg DCP, 1 (one) No. 10 Kg DCP & 1 (one) No. 8.8 Kg CO₂ extinguishers per two pumps up to a maximum of 4 nos.

iii. Scraper Barrel area: 1 (one) No. 10 Kg DCP extinguisher.

iv. Sump Pump, Transmix Pump & Oil Water Separator Pump: 1 (one) No. 10 Kg DCP extinguisher.

v. Control Room: 2 (Two) Nos. 2.5 Kg Clean Agent and 1 (one) No. 4.5 Kg CO₂ extinguisher.

vi. UHF / Radio Room: 2 (Two) Nos. 2.5 Kg Clean Agent and 1 (one) No. 4.5 Kg CO₂ extinguisher.

vii. UPS / Charger Room: 1 (one) No. 2 Kg, CO₂ extinguisher.

viii. Meter Prover / Separator Filter: 1 (One) No. 10 Kg DCP extinguisher.

ix. Repeater Station / CP - Repeater Station / SV station: 1 (one) No. 10 Kg DCP & 1 (one) No. 2 Kg CO₂ extinguisher.

x. Mainline Emergency Equipment Centre: 4 (Four) Nos. 10 Kg DCP & 2 (Two) Nos. 2 Kg CO₂ extinguishers.

xi. Air Compressor area: 1 (one) No. 2 Kg CO₂ & 1 (one) No. 5 Kg DCP extinguisher.

xii. Workshop: 1 (one) No. 10 Kg DCP extinguisher & 1 (one) No. 2 Kg CO₂ extinguisher.

xiii. Security Cabin: 1 (One) No. 10 Kg DCP extinguisher per cabin.

xiv. Oil Sample Storage Room: 1 (one) No. 10 Kg DCP extinguisher per 100 m² or min. 1 no. 10 Kg extinguisher per room whichever is higher.

xv. Effluent Treatment Plant area: 1 (one) No. 75 Kg. & 2 (Two) nos. 10 Kg. DCP extinguisher.

xvi. Transformer area: 1 (one) No. 10 Kg. DCP extinguisher per transformer.

xvii. Office / Store / Canteen: 1 No. 10 Kg DCP extinguisher for 100 m².

xviii. MCC / DG Room / HT Room: 2 (Two) number of 4.5 kg CO₂ based in each room or per 100 m² floor area.

xix. Intermediate pigging station: 1 (one) no. 75 kg and 1 (one) number 2 kg CO₂ based.

xx. Delivery / Terminal station: 1 (one) no. 75 Kg and 1 (one) 10 Kg DCP based and 1 (one) number 2 kg CO₂ based.

13.5.2 Wheeled Fire Fighting Equipment and Foam compound trolley shall be provided at installation.

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
as per OISD-STD-117.

13.5.3 Spares: 100% spares for CO₂ cartridges and 50% spares for DCP cartridges shall be stored.

13.5.4 A trolley containing first aid fire protective accessories shall also be provided.

13.5.5 First Aid and Safety Equipment:
The following minimum no. of Personal protective Equipment, First Aid Equipment & Safety instruments shall be provided as indicated against each item at each pump station / delivery / terminal station.
   a. Safety helmets-1 no./person (min 10 nos.).
   b. Stretcher with blanket- 2 Nos.
   c. First aid box- 1 nos.
   d. Rubber hand gloves for electrical purpose- 2 nos.
   e. Fire proximity suit- 1 no.
   f. Resuscitator - 1 No.
   g. Red / green flags – 2 nos. In each colour
   h. Self contained breathing apparatus with one spare cylinder (cap 30 min) – 1 set with spare cylinder.
   i. Water jel blanket- 1 nos.
   j. Explosive meter – 1 No.
   k. Sand bucket – 5 Nos.

13.5.6 Inspection of fire fighting equipment and system shall be carried out inline with OISD –Std - 142.

13.6 Windsock
Windsock shall be provided on an appropriately elevated structure like the control room / fire-water pump house. Wind socks shall be installed in such a way at several places that at least one wind sock shall be visible from any point in the installation.

13.7 Emergency Power supply
Emergency lighting shall be provided for operating areas like generator room, diesel compressor room, PCC/MCC room and control room. Emergency power supply shall also be provided to panels of all fire alarm/detection system/other fire fighting system.

13.8 Communication System
   (i) Communication system like telephone / PA or paging, walkie-talkie, optical fibre cable based communication system shall be provided.
   (ii) All intermediate stations including IP stations / Repeater station shall be provided with proven communication system. Security at unmanned station shall be trained to deal with communication and emergency handling.

13.9 Emergency Response Plan (ERP) / Disaster Management Plan (DMP)
13.9.1 An exhaustive crisis management system for onsite and offsite on ‘Emergency Preparedness Plan or Disaster Management Plan’ to combat oil leak, burst or fire, shall be prepared considering effective use of available resources. Broad guideline on the content of ERP for different types of emergencies likely to occur in cross country pipelines is given below:-
   (i) Objective of ERP should be to minimise the loss of life, injuries, properties, production loss due to prolonged shutdown and arranging relief and rehabilitation in shortest possible time.
   (ii) Type of Emergencies to be identified for example
      a. Fire at station due to leakage of oil, electrical short circuit, spark from Engine exhaust, mechanical seal failure, tank overflow etc.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
b. Fire at Mainline due to leakage / burst in mainline as result of corrosion, construction, sabotage pilferage or leakage from sectionalizing valves.

c. Natural calamities like Flood resulting in washout or breaches, Earthquake, Cyclonic Wind, Lightning, Landslides etc.

d. Any other

(iii) **Main and alternative Emergency Control Centre** : Location of the control room to be identified for each location which will start function immediately as and when emergency situation arise. Emergency Control Centre should have Landline & internal telephone, Layout Plan & P&ID of the station, mainline route map, sectionalizing valve locations, crossing locations and a copy of Emergency Preparedness Plan(EPP). Alternate emergency control centre should be located away from hazardous area in safe Zone.

(iv) **Team** : An organogram consisting of chief coordinator, operation coordinator, maintenance coordinator, communication coordinator, administrative & finance coordinator, combat team, rescue team, security co-ordinator etc. With detailed roles and responsibilities of each person by name & designation with an alternate name to tackle the emergency to be prepared.

(v) Conditions for declaring pipeline emergencies and its reporting system to be clearly defined.

(vi) Emergency preparedness plan for each category of emergency separately for Stations (including SV and IP) and mainline (Leak, Fire, Leak & Fire, Burst, Burst & Fire) the causes, consequences, control measures, emergency tools & tackles required, checklist for mobilization of Manpower and Equipment etc. To be made.

(vii) A detailed description of Dos and Don'ts if one notices a pipeline emergency.

(viii) Details of evacuation or in place sheltering procedure, clean up and restoration, post incident procedure

(ix) In case of major incident, procedure for reporting to Oil Industry Safety Directorate (OISD) and other statutory agencies like PESO and Factory Inspectors etc.

(x) A detailed list of various agencies (District Administration, Police, Hospitals, Ambulance services, State Fire services) their telephone no, fax no and address.

(xi) A detailed procedure for communication with outside agencies like District Magistrate, Police, Hospital, Village head, PWD / Irrigation authorities and information to public through press / media during disaster shall be developed.

13.9.2 A copy of the ON site ERP / DMP shall be forwarded to local Factory Inspector for their approval. Subsequently the Onsite and Offsite ERP / DMP shall be forwarded to District Magistrate / District collector.

13.9.3 Fire drills shall be conducted at each station once in a month considering different fire / risk scenarios and the findings / short comings of such drills will be recorded and maintained.

13.9.4 A mutual aid scheme for the fire fighting and emergency rescue operation shall be in place involving nearby industries. Such mutual aid scheme shall be activated during emergency drill (Onsite and Offsite) and the response of the mutual aid partners shall be recorded and maintained. Onsite emergency drill shall be conducted every six months and Offsite emergency drill shall be conducted once in a year involving concerned authorities.

14.0 **OPERATION AND MAINTENANCE**

A detailed operation and maintenance procedure for control system and safety interlocks shall be developed for each pipeline section and station. Site specific "Standard Operating procedure (SOP)" shall be developed.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
14.1 Operating Procedures / Manual
A comprehensive operating procedure / manual shall be developed which shall include as a minimum following:
(i) System Description
(ii) Operation set (trip / alarm) points
(iii) Initial start up
(iv) Normal operations
(v) Normal shut down procedure
(vi) Conditions under which emergency shutdown is required
(vii) Emergency shut down (ESD) procedures including conditions causing ESD.

14.2 Display of Operating Instructions
The gist of operating instructions, emergency shut down (ESD) procedure, ESD Trip set pressures shall be displayed / made available in the control room and near all important operating equipments.

14.3 If a piping system is de-rated to a lower operating pressure in lieu of repair or replacement, the new MAOP shall be determined.

(i) A detailed maintenance procedure / manual shall be developed for entire pipeline system considering the recommendations given by the Original Equipment Manufacturer (OEM) keeping in mind the local conditions. The manual shall include preventive maintenance schedule with periodicity i.e daily, weekly, monthly, half yearly and yearly.
(ii) Procedures for emergency repair of piping / pipelines using repair clamps, hot tapping and stopple plugging, and other repair methods should also be included as part of manual.
(iii) For repair / maintenance works, work permit system inline with OISD-STD-105 shall be developed and complied.

14.4.1 Maintenance of RoU / ROW and inspection of crossings
(i) RoU / ROW and access to various stations including valve location shall be maintained to ensure reasonable access to maintenance crews. Maintenance of ROW / RoU as a minimum shall include the following:
   a) controlling vegetation growth.
   b) preventing encroachment from above and belowground structures.
   c) controlling erosion
   d) maintaining visibility of pipeline markers

(ii) Road and railway crossings shall be inspected at least once in three (3) months. Where pipes are cased, it shall be ensured that casings are free of water and muck.

(iii) Water body crossings shall be inspected at least twice a year i.e prior to and after monsoon or flash flood for exposure, accumulation of debris, or for any other condition that may affect the safety and security of the crossings. Exposed length of pipeline, if any, falling in Inter-tidal Zones shall be inspected once in a quarter for checking the condition of coating and wrapping for taking corrective action.

(iv) Pipelines at Rail / Road Bridge, Suspended crossings shall be inspected once in three (3) months to check wear and tear of supports/structures and condition of anti corrosion coatings at the points where pipe exits and enters the ground. Ultrasonic thickness measurements shall be taken on exposed sections of the pipeline once in four years. Thickness measurement shall be taken at 4 locations (i.e. 12, 3, 6 and 9 O’clock positions) at the exits, bends and at every ten metre interval of exposed piping.

14.4.2 Patrolling

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Each operating company shall maintain a periodic pipelines patrol programme. Patrolling shall be carried out at the following minimum intervals.

(a) Patrolling (Ground / Aerial) of ROW / RoU shall be carried out twice in a week (urban areas and non urban areas) to observe surface conditions, leakage, construction activity other than performed by the pipeline owning company, encroachments, washouts and any other factors affecting the safety and operation of the pipeline.

(b) Line Walk by the official of the company at least once in a year for entire length of pipeline shall be carried out after the monsoon.

(c) Villagers / public along the right of away shall be adequately made aware of the possible consequence of hydrocarbon leaks and this shall be included as a part of regular audit.

(d) Round the clock patrolling by Line walkers or alternative security surveillance system shall be implemented where the pipeline location is vulnerable from pilferage point of view.

14.4.3 Pigging

The frequency of descaling of pipelines transporting crude petroleum and petroleum products shall be as under:

i) Non ATF Petroleum Product Pipelines - Once in six months.

ii) ATF pipelines also carrying other petroleum products - Once in three months.

iii) Dedicated ATF Pipelines – Once in a year.

iv) Crude Oil Pipelines – Once in three months.

Record of quantity and quality of deposits (pig residue) collected after descaling shall be examined to monitor condition of the Pipeline. Depending upon the out come of the chemical analysis and review, pigging frequency may be increased.

14.4.4 Instrumented / Intelligent Pigging

The first inspection of cross country pipeline by Instrumented / Intelligent pigging survey (IPS) shall be carried out at the earliest but not later than 10 years of commissioning. The result of this inspection shall be compared with original commissioning data in order to assess the health of the pipeline and subsequent periodicity of intelligent pigging. The frequency of Instrument / Intelligent pigging shall, in no case, be more than 10 years.

14.4.5 Load Lifting Equipment.

All the lifting equipment, wire ropes, tackles etc. Shall be inspected once in a year as per Factory’s Act, OISD-RP-205 shall be referred for guidance.

14.4.6 Pipeline Maintenance Equipment.

The specialised pipeline maintenance equipment required for maintenance of pipeline shall be inspected once in three months. An indicative list of equipment required to be kept at the pipeline maintenance base station is enclosed at Annexure – VIII.

14.4.7 Mainline Block Valves

Pipeline block valves shall be inspected, serviced where necessary, and shall be checked by operating partially / fully (as applicable) at least once in a year to assure proper operating conditions.

14.4.8 Inspection of Cathodic Protection System

14.4.8.1 Pipe to Soil Potential (PSP) Readings shall be taken as follows:

i. PSP readings at feeding points shall be monitored fortnightly.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
ii. The PSP reading (ON potential) at the test lead points for entire pipeline shall be taken once in a quarter. The PSP survey results shall be plotted graphically to identify and locate cathodic holidays.

iii. Instant pipe to soil “OFF” potential readings at test lead points of entire pipeline shall be taken once in a year. For the purpose of logging the instant OFF PSP, care shall be taken to minimize the effect of polarization decay., by logging the reading within the first 1 second of simultaneous GPS Synchronized switching off all Cathodic protection station affecting that section of the pipeline. CPTR Cycle shall be set at 16 seconds ON / 4 seconds OFF to minimize pipeline polarization.

iv. The ON / OFF PSP survey data along with Pearson survey or CAT / DCVG survey and soil resistivity & soil chemical analysis data shall be plotted graphically in one page / sheet to identify coating holidays.

**14.4.8.2** The Criteria of protection shall be as under

(i) Pipe to soil potential of at least (-) 0.85 volts with respect to copper/copper sulphate half cell. In areas where anaerobic bacteria are active, minimum PSP shall be more negative than – 0.95 volts instead of – 0.85 volts.

(ii) A minimum of 100 mV of cathodic polarization between the structure surface and a stable reference electrode containing the electrolyte. The formation of decay of polarization can be measured to satisfy this condition.

(iii) Over protection of coated pipelines shall be avoided by ensuring that polarisation potential is not more negative than (-) 1.2 volts with respect to copper/copper sulphate half cells.

(iv) The instant OFF PSP at the TLPs should not be less than (-) 0.85 volt / (-) 0.95 volt and more than (-) 1.2 volt.

(v) Such measurement wherever influenced by multiple pipelines in the same ROW / ROU to be valid after switching off the other pipeline.

**14.4.8.3** Current consumption data shall be taken once in a year at the test stations where current measurement facility exist.

**14.4.8.4** Cathodic protection rectifiers shall be inspected once in three months.

**14.4.8.5** All protective devices shall be inspected once in three months.

**14.4.8.6** Interference bonds shall be inspected once a year.

**14.4.8.7** Polarization cells [electrolytic type] shall be inspected every three (3) months and electrolyte level top up to be done after every Inspection.

**14.4.8.8** At the crossing location of one pipeline with other pipeline, current and PSP data shall be taken once in 3 months.

**14.4.9 Coating Survey**

**14.4.9.1** Close Interval Potential survey (CIPS) or Continuous Potential Logging (CPL) “On” & “Off” survey for every meter of pipeline ROW should be carried out once in five years.

**14.4.9.2** Coating survey i.e. Pearson / Current Attenuation Test (CAT) / Direct Current Voltage gradient (DCVG) Survey shall be carried at probable coating defect location identified by CPL survey once in 5 years. The type of survey should be decided based on coating condition. In case CAT survey is selected, it shall be done at intervals of 50m.

**14.4.9.3** Survey Results to be collated as Status Report and compared with Original Post Commissioning survey results.

**14.4.10 Insulating Joint / Insulating Coupling**

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Insulating joints and couplings shall be inspected once in a year.

14.4.11 Soil Testing
If any industrial effluent is flowing over the ROW/ROU or any environmental change is noticed on the ROW, the soil samples shall be tested for determining the efficacy of the existing coating and wrapping of the pipeline.

14.4.12 Back Up Power for CP System
Wherever the availability of power supply from State Electricity Board to the CP system is not reliable suitable back up power (battery bank / Inverter / DG) shall be provided so as to provide minimum 90 % time power to C.P system.

14.4.13 Safety Appliances.
Safety appliances provided against lightning, stray current interference from foreign objects at pipeline crossings etc. Shall be maintained once in six months and updated records shall be maintained.

14.4.14 Electrical Equipment.
Maintenance and Inspection of Electrical equipment shall be carried out in line with OISD – STD-137, OISD-RP-147.

14.4.15 Internal Corrosion Monitoring
Corrosion monitoring facilities (i.e. corrosion coupons and probes based on electrochemical noise technique (ER probes), electrochemical noise technique (ECN probes) or Linear polarisation technique (LPR probes) etc., shall be installed at the stations to monitor the internal corrosion. If the rate of corrosion is more than 1 MPY, suitable doses of corrosion inhibitor shall be dosed.

14.4.16 Inspection of Pipes, Valves and fittings
Above ground piping and accessories shall be inspected visually once in a year for external corrosion. Ultrasonic thickness measurements shall be taken on exposed sections of the pipe once in three (three) years for sour crude and product and once in four (four) years for sweet crude and product. Thickness measurement shall be taken at 4 locations (i.e. 12, 3, 6 and 9 O’clock positions) at the exits, bends and at every ten metre interval of exposed piping. Inspection of pipes, valves and fittings shall be carried out as per OISD-STD-130.

14.4.17 Inspection of Pumps, Compressors, Control and Protective Equipment
Periodic inspection and maintenance shall be carried out for control and protective equipment including pressure limiting devices, regulators, controllers, relief valves and other safety devices as per recommendations of OEM (Original Equipment Manufacturer) and following OISD standards.
(i) Pumps : OISD-STD-119,
(ii) Compressors : OISD-STD-120,
(iii) Turbine and Diesel Engine - OISD-STD-121,
(iv) Fan, Blowers, Gear boxes, Agitators and mixers – OISD-RP-122,
(v) Rotary Equipment components – OISD-RP-123,
(vi) Inspection and Maintenance of Mechanical Seals- OISD-STD-125,
(vii) Inspection of Unfired Pressure Vessels including basket filters – OISD-STD-128
(viii) Inspection of Sump Tank / Storage Tanks – OISD-STD-129

14.4.18 Leak Detection System.
(i) If any leak detection system is installed on the pipeline system, it shall be checked for effectiveness of operation once in a year.
(ii) A daily, monthly & yearly reconciliation record of crude / product received from tank, line fill quantity and delivered quantity shall be maintained to ascertain the

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
transportation loss through pipeline. In case the loss is more than the limit specified by the company, an analysis shall be carried out to ascertain the probable cause of the loss.

14.4.19 Telecommunication System / Equipment.
   i) Detailed System functional tests shall be carried out once in six months.
   ii) Telecommunication equipment shall be inspected as per manufacturer's recommendation.

14.4.20 Telemetry System / Equipment.
   i) Detailed System functional tests shall be carried out once in six months.
   ii) Telemetry equipment shall be inspected as per manufacturer's recommendation.

14.4.21 Safety Instrumentation.
Operation system interlock checking shall be carried out once in a year. Maintenance and Inspection of Safety Instrumentation shall be carried out as per OISD-STD-153.

14.4.22 Fire Fighting Equipment.
Maintenance and Inspection of Fire Fighting Equipment shall be carried out as per OISD – STD-142.

15.0 MANAGEMENT OF CHANGE / SAFE CONTROL OF OPERATIONS (SCO)
For Safe Control of Operations (SCO), a systematic Management of Change process shall be developed inline with OISD-GDN-178 to identify and consider the impact of changes to pipeline systems and their integrity. Management of Change shall address technical, physical, procedural and organizational changes of the system, whether permanent or temporary.

16.0 DEFECT DETECTION, ASSESSMENT AND MITIGATION
Effective defect detecting systems like, pipeline patrolling / surveillance, visual / UT inspection, leak detection tests, internal audits, external audits etc. shall be put in place for detection of defects and damages of pipe work. Defective or Damaged pipelines shall be identified and restored to safe operating conditions by the use of appropriate repair methods as per this standard.

Defects shall be categorized into superficial damage, moderate damage, severe damage and extreme damages etc.

The selection of the most appropriate repair method, consistent with safety of operation, shall be selected based on assessment of the defect.

17.0 PIPELINE INTEGRITY MANAGEMENT (PIM)
17.1 The initial integrity of the pipeline is established through proper design, material selection and sound construction practices. After the pipeline has been commissioned and is in operation, a programme of condition monitoring and maintenance shall be undertaken to ensure integrity is maintained.

17.2 A comprehensive manual containing program and practices shall be developed for existing pipeline / after construction of the new pipeline to manage pipeline integrity taking into consideration consequence classification / category of pipeline, and risk involved in each segment of the pipeline.

17.3 The integrity management program framework shall take into consideration continual / periodic assessment and an evaluation process to know the current health of the pipeline & to prevent any failure in future.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
17.4 To maintain safe operating conditions in case of an adverse condition detected, pipeline should be shut down until the required repairs are completed and clearance for operation is given.

17.5 The methods selected to assess the integrity of the pipeline shall be one and/or combination of the followings:
   (a) Internal inspection tool or tools capable of detecting corrosion and deformation anomalies including dents, gouges, grooves e.g. Instrumented / Intelligent Pigging in accordance with clause 14.4.4 of this standard.
   (b) Pressure testing for operating pipelines or pipeline section be done once in 5 years and test shall be 1.25 times the maximum operating pressure which shall be held for a period of 24 hours. Acceptability of the test shall be in accordance with clause 12.3(d) of this standard.

17.6 The integrity assessment during the lifetime shall consist of an initial (base line) & continual assessment.

17.7 The factors to be considered for risk are:
   (a) Results of previous integrity assessment,
   (b) Coating type and condition
   (c) Leak history
   (d) Repair history
   (e) Cathodic protection history

17.8 System should be available for detecting leaks of pipeline system. The capability of the leak detection system shall be evaluated and modified if necessary.

18.0 Pipeline Repair
   Repairs shall be covered by a maintenance plan and shall be performed under qualified supervision by trained personnel. Precautionary measures and procedures outlined in API Publ. 2200 should be followed.

18.1 In case of corrosion in the pipe due to which thickness of the pipe is reduced to the extent that maximum allowable operating pressure is required to be reduced from original design to meet requirement of this standard, then either the pipe section shall be repaired or replaced or the pipeline shall be de-rated commensurate with remaining strength of the pipe.

18.2 Repair welding procedures and welders performing repair work shall be qualified in accordance with API standard 1104 or section IX of the ASME Boiler and Pressure vessel code.

18.3 Corrosion
   a. Areas of external or internal metal loss with a maximum depth greater than 50% pipe thickness and length equal half of pipe thickness shall be removed or repaired.
   b. Externally corroded areas exposed for examination shall be cleaned to bare metal. In general, areas of corrosion with a maximum depth of 20% or less of the thickness required for design (t) need not be repaired. However, measures should be taken to prevent further corrosion. An area of corrosion with maximum depth greater than 20% but less than or equal to 50% of the wall thickness can be permitted to remain in the pipeline unrepaired provided that the pressure at such an area does not exceed a safe level. Calculations for safe operating pressure shall be done as per ASME B31G.
   c. If the safe operating pressure is less than the intended operating pressure, the affected area shall be removed or repaired.

18.4 Assessment and repair of any Dents found in operating pipeline should be in line with ASME B31.4 and ASME PCC 2. However, for repair / replacement requirement of pipe related to corrosion para 18.3 shall prevail over ASME B31.4 and ASME PCC 2.

18.5 Cross country pipeline maintenance base station / station shall be equipped with accessories, tools, tackles & kit for arresting leak. Pipeline shall be repaired by any one of the following:

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
a) By cutting out cylindrical piece of pipe containing the defect and replacing the same with a pre tested pipe of minimum 2 meter length of meeting the required pipe specification.

b) By installing full encirclement welded split sleeves to contain internal pressure and shall have a design pressure of not less than the maximum allowable operating pressure. This shall be fully welded both circumferentially and longitudinally. Length of full encirclement split sleeves shall not be less than 100mm.

c) All repairs performed as per (a) above shall be tested by radiography examination.

d) In case of repair of coated pipe, all damaged coating shall be removed and new coating shall be applied to replacement pieces of pipe, welded patches and full encirclement welded split sleeves used in making repairs.

e) Composite sleeves may be used to repair defects that have been removed by grinding. Composite sleeves shall not be used to repair of leaks, metal loss with a depth greater than 80% of the nominal wall thickness, cracks, or circumferentially oriented defects.

f) Mechanical Bolt-on-Clamp. Repairs may be made to both leaking and non-leaking defects by the installation of a mechanically applied clamp. A mechanical clamp shall have a design pressure of not less than that of the pipe being repaired. Mechanical clamps shall not be used to repair circumferentially oriented defects unless designed to withstand the axial load. A mechanical clamp shall be fully welded, both circumferentially and longitudinally and seal welded at bolts. The clamp ends shall extend past the edges of the defect for a minimum of 50 mm.

g) Defects may be removed by hot tapping. When hot tapping is used as a means of repair, procedure for hot tapping shall be made before execution of the work, treatment for heat affected zone shall be done and the portion of piping containing the defects shall be completely removed.

h) Fittings. Minor leaks resulting from external corrosion and small externally corroded areas may be repaired by the installation of a welded fitting. Welded fittings used to cover pipeline defects shall not exceed NPS 3 and shall have a design pressure of not less than the pipe being repaired. Pipe containing arc burns, grooves, and gouges may be repaired with a welded fitting if the arc burn or stress riser associated with the gouge or groove is removed by grinding. No crack shall be repaired by this method.

i) Patches and Half Soles. Neither patches nor half soles shall be installed on pipelines.

18.6 Testing Repairs to Pipelines
When a repair to a pipeline is made by cutting out a section of the pipe as a cylinder and replacing it with another section of pipe, the replacement section of pipe shall be pre tested to a pressure equal to 1.25 times the design pressure of the parent pipeline for minimum period of 4 hrs. prior to installation. Radiographic inspection shall be carried out on all tie-in-butt weld joints after the installation.

18.7 At the identified maintenance base station for the pipeline, a pipe size and length equal to the longest river crossing section length of the laid pipeline shall be preserved as insurance stock pipe.

19.0 Static Leak test.
Static Leak Test of the pipeline shall be performed at least once in five year using the liquid transported through the pipeline. The static leak test is used only to quantify the pressure and liquid containment capability of an existing Pipeline System at shutdown pressure. API 1110 shall be referred for guidance.

20.0 ABANDONMENT OF PIPELINE

20.1 A pipeline system that is no longer required for transportation of hydrocarbon shall be taken out of service with all hazardous fluids removed from the system. In case a operating company

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
decides to abandon full or part of the pipeline system permanently or temporarily after obtaining necessary approval from the statutory authority (if required), it shall prepare a detailed plan considering the following.
(i) Pipeline section and facilities shall be disconnected with positive isolation from all source of supply of hydrocarbon prior to abandonment.
(ii) Pipeline system and facilities to be abandoned shall be purged with nitrogen gas or inert materials or inhibited water and ends shall be sealed.

20.2 Plans and procedures shall be developed for safe decommissioning, dismantling, demolition, and disposal of the pipeline.
(i) Maintenance of the facility shall continue till full dismantling of facilities have been completed.
(ii) Cathodic protection system shall be maintained with periodic inspection.
(iii) Environmental impact assessment to be carried out on account of dismantling.

21.0 Documentation for Operation and Maintenance

The following records shall be maintained for operation and maintenance purposes:

  i. All records as per para 12.8 of this document.
  ii. Operation daily logs
  iii. Pipeline patrolling records
  iv. Encroachment Records.
  v. Pipeline pigging records
  vi. Records and maps showing the location of CP facilities and piping.
  vii. CP monitoring report, test and survey reports.
  viii. Leak, burst & repair records
  ix. Records pertaining to inspections, such as external or internal line conditions
  x. Pipeline repair records
  xi. History cards of equipment
  xii. Near miss, minor and major incidents.

22.0 AUDITS

There shall be a system for ensuring compliance to the provision of this standard by conducting following technical and safety audits during operation phase.

  i. Internal Safety Audit as per the checklist for cross country pipelines provided in OISD-GDN-145 shall be carried out by the management of operating company once in a year.

  ii. External Safety Audit (ESA) by OISD, as per the methodology approved by Safety Council, MoP&NG. Present approved frequency is as follows:
      a. 1st round of ESA within one year of commissioning.
      b. 2nd round of ESA after 3 years of 1st round of ESA
      c. Every 5 years after 2nd round of ESA.

  iii. Surprise Safety Audit after 2nd round.

23.0 REFERENCES:

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

<table>
<thead>
<tr>
<th>OISD-STD-105</th>
<th>Work Permit System</th>
</tr>
</thead>
<tbody>
<tr>
<td>OISD-STD-118</td>
<td>Lay out of Oil and Gas Installation</td>
</tr>
<tr>
<td>OISD-STD-119</td>
<td>Selection, Operation and Maintenance of Pumps</td>
</tr>
<tr>
<td>OISD-STD-121,</td>
<td>Inspection of Turbine and Diesel Engines</td>
</tr>
<tr>
<td>OISD-RP-122,</td>
<td>Selection, Operation and Maintenance of Fan, Blowers, Gear boxes, Agitators and mixers</td>
</tr>
</tbody>
</table>

“OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines.”
<table>
<thead>
<tr>
<th>OISD-STD-123,</th>
<th>Selection, Operation and Maintenance of Rotary Equipment components</th>
</tr>
</thead>
<tbody>
<tr>
<td>OISD-STD-124,</td>
<td>Predictive Maintenance Practices</td>
</tr>
<tr>
<td>OISD-STD-125,</td>
<td>Inspection and Maintenance of Mechanical Seals</td>
</tr>
<tr>
<td>OISD-STD-128,</td>
<td>Inspection of Unfired Pressure Vessels.</td>
</tr>
<tr>
<td>OISD-STD-129,</td>
<td>Inspection of Storage Tanks</td>
</tr>
<tr>
<td>OISD-STD-130,</td>
<td>Inspection of Pipes, Valves and Fittings.</td>
</tr>
<tr>
<td>OISD-STD-132,</td>
<td>Inspection of Pressure Relieving Devices.</td>
</tr>
<tr>
<td>OISD-STD-137,</td>
<td>Inspection of Electrical Equipment.</td>
</tr>
<tr>
<td>OISD-STD-139,</td>
<td>Inspection of Pipelines - Offshore</td>
</tr>
<tr>
<td>OISD-STD-140,</td>
<td>Inspection of Jetty Pipelines</td>
</tr>
<tr>
<td>OISD-STD-142,</td>
<td>Inspection of Fire Fighting Equipment.</td>
</tr>
<tr>
<td>OISD-RP-149,</td>
<td>Design aspect for safety in Electrical system</td>
</tr>
<tr>
<td>OISD-STD-153,</td>
<td>Maintenance and Inspection of Safety Instrumentation.</td>
</tr>
<tr>
<td>OISD-STD-163,</td>
<td>Safety of Control Room for Hydrocarbon Industry</td>
</tr>
<tr>
<td>OISD-GDN-178,</td>
<td>Guidelines on Management of Change</td>
</tr>
<tr>
<td>OISD-STD-214,</td>
<td>Cross country LPG Pipelines</td>
</tr>
<tr>
<td>ASME B31.4</td>
<td>Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids</td>
</tr>
<tr>
<td>ASME PCC-2</td>
<td>Repair of Process equipment and Piping</td>
</tr>
<tr>
<td>ASME B 31.3</td>
<td>Process piping.</td>
</tr>
<tr>
<td>ASME B 31 G</td>
<td>Manual for determining the remaining strength of corroded pipelines</td>
</tr>
<tr>
<td>ASME B16.33</td>
<td>Manually operated Metallic gas valves for use in gas piping system.</td>
</tr>
<tr>
<td>ASME - Boiler and Pressure Vessel Code</td>
<td>Section VIII Division – 1 : Pressure Vessel</td>
</tr>
<tr>
<td></td>
<td>Section VIII Division – 2 : Alternate Rules for Pressure Vessels</td>
</tr>
<tr>
<td></td>
<td>Section IX: Welding and Brazing Qualification</td>
</tr>
<tr>
<td>API 674</td>
<td>Positive Displacement Pumps – Reciprocating</td>
</tr>
<tr>
<td>API 675</td>
<td>Positive Displacement Pumps – Controlled volume</td>
</tr>
<tr>
<td>API 676</td>
<td>Positive Displacement Pumps – Rotary</td>
</tr>
<tr>
<td>API 1102</td>
<td>Recommended Practice for Steel Pipelines Crossing Railroads and Highways.</td>
</tr>
<tr>
<td>API 1104</td>
<td>Standard for Welding Pipelines and Related Facilities</td>
</tr>
<tr>
<td>API 1107</td>
<td>Recommended Pipeline Maintenance Welding Practices</td>
</tr>
<tr>
<td>API 1109</td>
<td>Recommended Practice for Marking Liquid Petroleum Pipeline Facilities</td>
</tr>
<tr>
<td>API 1110</td>
<td>Recommended Practice for Pressure Testing of Liquid Petroleum Pipelines.</td>
</tr>
<tr>
<td>MSS-SP-50</td>
<td>Pipe Hangers and Supports Materials, Design and Manufacture</td>
</tr>
<tr>
<td>MSS-SP-69</td>
<td>Pipe Hangers and Supports - Selection and Application.</td>
</tr>
<tr>
<td>NACE-SP-01-69</td>
<td>Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Pipng Systems</td>
</tr>
<tr>
<td>NACE-SP-01-75</td>
<td>Recommended Practice - Control of Internal Corrosion in Steel Pipelines Systems.</td>
</tr>
<tr>
<td>ISA S-75.01</td>
<td>Flow evaluation for sizing control valve</td>
</tr>
<tr>
<td>ISA S-75.02</td>
<td>Control valve test procedure</td>
</tr>
<tr>
<td>IS/IEC–60079-0 : 2004</td>
<td>Electrical Apparatus for Explosive Gas Atmosphere</td>
</tr>
<tr>
<td>IS/IEC – 60529 : 2001</td>
<td>Degree of protection Provided by Enclosures.</td>
</tr>
<tr>
<td>IS–:5572</td>
<td>Electrical area classification of Installation for selection of Electrical Equipment</td>
</tr>
<tr>
<td>IS: 5571</td>
<td>&quot;Guide for selection of Electrical Equipment for Hazardous Area&quot;.</td>
</tr>
<tr>
<td>IS :3043</td>
<td>For earthing of all electrical equipment, systems, structures and fencing, etc.</td>
</tr>
</tbody>
</table>

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
IS:2309  Lightening protection
### ANNEXURE-II

#### MINIMUM INTER DISTANCES FOR VARIOUS STATION FACILITIES

<table>
<thead>
<tr>
<th>S. No</th>
<th>From / To</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Booster/Mainline Pump shed</td>
<td>x</td>
<td>16</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Scraper Launcher/Receiver</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>30</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Filters / Metering / Sampling point / Sump Tanks</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Control Room UPS / SCADA-Telecom/Office building</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>x</td>
<td>16</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>30</td>
<td>x</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>Fire Pump House/ Fire water storage tanks</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>16</td>
<td>x</td>
<td>12</td>
<td>x</td>
<td>16</td>
<td>60</td>
<td>x</td>
<td>x</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Compound wall</td>
<td>30</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>12</td>
<td>x</td>
<td>x</td>
<td>6</td>
<td>16</td>
<td>x</td>
<td>5</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>Elect Substation/ Switch Yard / Transformers</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>#</td>
<td>#</td>
<td>16</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>Motor Control Centre / Power Control Centre/Variable Frequency Drive</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>x</td>
<td>16</td>
<td>6</td>
<td>x</td>
<td>x</td>
<td>#</td>
<td>#</td>
<td>16</td>
<td>16</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>9</td>
<td>API Oil Water Separators (open type)</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>60</td>
<td>16</td>
<td>#</td>
<td>#</td>
<td>x</td>
<td>#</td>
<td>x</td>
<td>#</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>Service Building(Stores / Amenities)</td>
<td>30</td>
<td>16</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>x</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>11</td>
<td>Station Block Valves</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>x</td>
<td>5</td>
<td>16</td>
<td>16</td>
<td>x</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>12</td>
<td>Metering System</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>13</td>
<td>Sump tank (U/G)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>14</td>
<td>API Separator (closed type)</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>16</td>
<td>30</td>
<td>30</td>
<td>x</td>
<td>16</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Note:**
(i) All distances are in meters. All distances shall be measured between the nearest points on the perimeter of each facility.
(ii) # - Safety distances as per OISD-STD-118.
(iii) For other station facilities not covered in the above shall be governed by OISD-STD-118.
(iv) x - Any distance suitable for constructional and operation convenience.
(v) Firewater hydrant / monitors shall be installed at a minimum 15m away from the equipment / facilities to be protected.
(vi) For the distance from compound wall, the distance mentioned in this table and the requirement of local by laws (if any) whichever is higher shall govern.
(vii) At pipeline’s loop line terminal location, distance between scraper barrel and compound wall shall not be less than 5 meter.
(viii) For SV station (Motor operated) distance between sectionalizing valve to compound wall shall be minimum 5 metre. All other safety distances at SV / CP stations to be kept as per operational convenience and applicable local statutory authorities if any.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
PROCEDURE FOR SAFETY INSTRUMENTED SYSTEM

1. Sample of Layers of Protection Analysis (LOPA) should be as depicted below:

2. Generalized procedure for the pipeline shall be as described below:

   (i) A detailed Hazard & Risk Analysis of the proposed/existing Pipeline Systems, Pumping /Booster/TOPS/Terminal Stations shall be undertaken by a multi-disciplinary team of Senior Management Executives.

   (ii) The outputs of the detailed study will be a listing of all foreseeable Hazards, its probability of occurrence and impact on Plant, Humans and Environment (Operational, Corrosion Related, Caused by Third party acts as well as due to Natural Calamities and Accidents). Suitable Standards of the Insurance and/or other relevant standards shall be referred for deciding the probabilities. For Hazards for which prior data is not available subjective probability shall be assigned based on the collective experience of the members. The methods for deriving these probabilities and assumptions made shall be documented.

   (iii) Then a comprehensive Layer of Protection Architecture (LOPA) shall be specified for reduction of the above Hazards. Hazards which can be reduced by application of SIS LOP (Safety Integrity System Layer of Protection) shall then be identified.

   (iv) Then for each identified SIS LOP, Safety Integrity Function (SIF) shall be defined.

   (v) For each SIF, the SIL Level shall be defined based on the level of risk reduction desired.

   (vi) A sample of SIF with SIL is given at Table-A below for guidance (Any other method of documenting is also acceptable. But it should be unambiguous with reasons for SIL selection properly documented).
Table No- A

<table>
<thead>
<tr>
<th>SIL</th>
<th>Availability</th>
<th>PFD (avg)</th>
<th>MTBF</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>&gt;99.99%</td>
<td>10⁻² to &lt; 10⁻¹</td>
<td>100000 to 10000</td>
</tr>
<tr>
<td>3</td>
<td>99.9%</td>
<td>10⁻³ to &lt; 10⁻²</td>
<td>10000 to 1000</td>
</tr>
<tr>
<td>2</td>
<td>99-99.9%</td>
<td>10⁻³ to &lt; 10⁻²</td>
<td>1000 to 100</td>
</tr>
<tr>
<td>1</td>
<td>90-99%</td>
<td>10⁻² to &lt; 10⁻³</td>
<td>100 to 10</td>
</tr>
</tbody>
</table>

PFD: Probability of Failure on Demand, MTBF: Mean Time between Failures

(vii) Once the SIFs are finalized the SIS architecture is to be conceptualized. A sample is given in Table - B below. Based on the probability of Nuisance Trip & expected loss of Thruput due to the combined effect of SIFs implemented, the Pipeline capacity to be suitably modified. The sample should not be considered as guidance for a typical SIS. The actual detailed engineering is left to the discretion of the Companies implementing the project.

Table- B

<table>
<thead>
<tr>
<th>SIF ID</th>
<th>SIF Description</th>
<th>Hazard</th>
<th>Inputs</th>
<th>Outputs</th>
<th>SIF Reason</th>
<th>Risk reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mainline High Discharge Pressure Shut Down the MPLUs &amp; activates ESD</td>
<td>Potential Rupture of the Mainline in Station or elsewhere</td>
<td>PT( )</td>
<td>DO( ) DO( ) AIO( )</td>
<td>2</td>
<td>1000 times</td>
</tr>
</tbody>
</table>

Table No- B Contd... SIS Calculations

<table>
<thead>
<tr>
<th>S No</th>
<th>Sensors</th>
<th>Logic Solver (PLC)</th>
<th>Final Element</th>
<th>Function Test/Maint Interval</th>
<th>SI L</th>
<th>PFDavg</th>
<th>MTTF S</th>
<th>Nuisance Trip Probability &amp; Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Pressure Switch (1001)</td>
<td>PLC id (1002) Ladde r_id</td>
<td>Valve Nos (1001)</td>
<td>6 months</td>
<td>1</td>
<td>3.58 x 10⁻²</td>
<td>13.6</td>
<td>1% Loss of tput 0.5% or 2 Hrs etc.</td>
</tr>
</tbody>
</table>

Note:-The above tables are samples. It is not intended as guidance for deciding the SIS architecture / SIS calculations

(viii) The above SIS architecture is then implemented. The SIS implementation can either be separate system or integrated with Process Control System. Where integrated with Process Control System the PE shall be Safety certified (TUV, FM or any other equivalent accredited agency)

(ix) During commissioning & once every five years the SIS shall be functionally validated. During the Maintenance, Functional checks of the SIFs shall be carried out as envisaged in the design. OISD 153 provides the minimum re-calibration intervals for Safety Instruments. The re-calibration can be more frequent if required and as envisaged in the design as described above.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
(x) Whenever any retrofitting to the plant is done, new processes are added, major repairs are carried out or any major modification to plant or operation philosophy is done, the above procedure shall be repeated to all applicable pipeline stations.

(xi) During the design of SIS, the useful design life of the system shall be evaluated and documented. Due consideration to be taken for deterioration in reliability due to ageing as well as availability of maintenance spares. The entire SIS shall be replaced upon completion of the design life. During replacement the entire procedure described above shall be implemented.

In the rare instance where from Engineering Estimation, Maintenance Data and other evidence it is decided to extend the operation of the SIS, approval for the extension shall be obtained from the Head of the Division/Plant and the same shall be documented. Upon completion of the extension period the above stated replacement procedure shall be followed.
LIST OF ENGINE MONITORING AND PROTECTION INSTRUMENTATION

The following minimum essential instruments shall be provided on the control panel and a signal may be extended to the control room computer.

<table>
<thead>
<tr>
<th>Function</th>
<th>Indication</th>
<th>Alarm</th>
<th>Shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Speed</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Hours run</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine vibration</td>
<td>X</td>
<td></td>
<td>HH</td>
</tr>
<tr>
<td>Cylinder head vibration (1)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbocharger vibration</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Fan vibration</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Start sequence</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start sequence fail</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Controls fail</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>TEMPERATURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lube oil to engine</td>
<td>X *</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L(3)</td>
<td></td>
</tr>
<tr>
<td>Lube oil to cooler</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Lube oil from cooler</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Coolant to engine</td>
<td>X</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Coolant from engine (2)</td>
<td>X *</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Air inlet manifold</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust – each cylinder</td>
<td>X</td>
<td>XH</td>
<td>XL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust – turbocharger inlet</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust – turbocharger outlet</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main bearings</td>
<td>X</td>
<td></td>
<td>HH</td>
</tr>
<tr>
<td>Big end bearings</td>
<td>X</td>
<td></td>
<td>HH</td>
</tr>
<tr>
<td>Turbocharger bearings</td>
<td>X</td>
<td></td>
<td>HH</td>
</tr>
</tbody>
</table>
### Annexure IV contd...

<table>
<thead>
<tr>
<th>Function</th>
<th>Indication</th>
<th>Alarm</th>
<th>Shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRESSURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lube oil</td>
<td>X *</td>
<td>L</td>
<td>LL *</td>
</tr>
<tr>
<td>Coolant</td>
<td>X</td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Starting air</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Hydraulic start accumulator</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td><strong>DIFFERENTIAL PRESSURE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lube oil filter</td>
<td>X *</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td>Air filter</td>
<td>X *</td>
<td>H</td>
<td>HH</td>
</tr>
<tr>
<td><strong>LEVEL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lube oil slump</td>
<td>X *</td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Coolant</td>
<td>X *</td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Air filter oil bath</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Fuel day tank</td>
<td>X *</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td><strong>ELECTRICAL / INSTRUMENTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains power</td>
<td>X *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Battery voltage</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Battery charger on</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Instrument power</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Instrument pneumatic pressure</td>
<td>X *</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

1. One per cylinder head for combustion diagnostics
2. Sensing points on each cylinder block
3. Start permissive
4. X Indicates a requirement
5. H Indicates alarm on high warning
6. L Indicates alarm on low warning
7. HH Indicates shutdown on high exceedance
8. LL Indicates shutdown on low exceedance

---

**ANNEXURE – V**

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Additional Requirements for Electric Welded Pipes

Electric Welded pipes shall meet following requirements.

1. **Reverse Bend Tests**
   Reverse bend tests shall be performed on the pipe piece cut from the crop end, selected from the front end of the first length and the back end of the last length produced from each coil. The specimen shall be 100mm to 115mm long and shall be reverse bend tested in accordance with procedure given below.

   ![Diagram of Reverse Bend Test](image)

2. **Selection of Mandrel**
   The reverse bend test shall be carried out with a mandrel, whose radius(R), width(A) shall be calculated for any combination of diameter, wall thickness and grade with the formula:

   \[
   A = 2R = \frac{1.4 \times (D-t) \times t}{e(D-2t)-1.4t}
   \]

   where,
   - \(D\) - Outside diameter of pipe
   - \(t\) - Wall thickness of pipe
   - 1.4 - Peaking factor
   - \(e\) - Strain

   Minimum values of ‘\(e\)’ shall be as follows:

<table>
<thead>
<tr>
<th>Grade of Steel</th>
<th>Min ‘(e)’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>API 5L B</td>
<td>0.1425</td>
</tr>
<tr>
<td>API 5L X-42</td>
<td>0.1375</td>
</tr>
<tr>
<td>API 5L X-46</td>
<td>0.1325</td>
</tr>
<tr>
<td>API 5L X-52</td>
<td>0.1275</td>
</tr>
<tr>
<td>API 5L X-56</td>
<td>0.1175</td>
</tr>
<tr>
<td>API 5L X-60</td>
<td>0.1125</td>
</tr>
<tr>
<td>API 5L X-65</td>
<td>0.1100</td>
</tr>
<tr>
<td>API 5L X-70</td>
<td>0.1025</td>
</tr>
<tr>
<td>API 5L X-80</td>
<td>0.0900</td>
</tr>
</tbody>
</table>

ANNEXURE – V Contd.

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
3. Procedure
The mandrel is to be plugged into the specimen, with the weld in contact with mandrel, to such a depth that the angle of engagement between mandrel and specimen reaches 60° (see Fig. above). If the combination of diameter and wall thickness of pipe, and radius of mandrel is such that the angle of engagement does not reach 60°, the mandrel shall be plugged into the specimen until opposite walls of the specimen meet.

4. Acceptance Criteria
A specimen which fractures completely prior to the specified engagement of mandrel and specimen, or which reveals cracks and ruptures in the weld or heat affected zone longer than 4mm, shall be rejected. Cracks less than 6mm long at the edges of the specimen shall not be cause for rejection.

5. Micrographic and Hardness Examination
A test specimen shall be taken across the longitudinal weld from one length of finished pipe from each lot of maximum 100 lengths from the same heat manufactured from the same process. These specimens shall be polished and etched for micro-examinations. The examinations shall provide evidence that heat treatment of weld zone is adequate and there is no untempered martensite left.

The Manufacturer shall make hardness measurements on each specimen as indicated in Fig. below in accordance with ASTM E-32. The maximum difference in hardness between base material and any reading taken in the heat affected zone shall be less than 80 points Vickers’ HV10.

- Location where hardness measurement to be carried out

---

Annexure – VI
(Clause 9.5.2.)

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
List of Specifications of Piping Materials used in liquid hydrocarbon Pipelines

<table>
<thead>
<tr>
<th>Steel Pipe</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>API 5L</td>
<td>Specification for Line pipes</td>
</tr>
<tr>
<td>ASTM A106</td>
<td>Seamless Carbon Steel Pipe for High Temperature Service</td>
</tr>
<tr>
<td>ASTM A333</td>
<td>Seamless and Welded Steel Pipe for Low-Temperature Service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valves</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>API 6D</td>
<td>Pipeline Valves</td>
</tr>
<tr>
<td>ISO – 14313</td>
<td>Pipeline Valve specification</td>
</tr>
<tr>
<td>ASME B16.34</td>
<td>Valves Flanged, Threaded and Welding End</td>
</tr>
<tr>
<td>BS 5352</td>
<td>Specification for steel wedge gate, globe and check valves 50 mm and smaller for the petroleum, petrochemical and allied industries.</td>
</tr>
<tr>
<td>BS 5351</td>
<td>Specification for steel ball valves for the petroleum, petrochemical and allied industries - Small Floating ball valve.</td>
</tr>
<tr>
<td>BS 1873</td>
<td>Specification for Steel globe and globe stop and check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flanges and Blanks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.5</td>
<td>Steel pipe flanges and flanged fittings - Size up to 24&quot; NB.</td>
</tr>
<tr>
<td>ASME B16.36</td>
<td>Orifice Flange</td>
</tr>
<tr>
<td>MSS SP-44</td>
<td>Steel Pipeline Flanges</td>
</tr>
<tr>
<td>API 590</td>
<td>Steel Line Blanks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fittings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.9</td>
<td>Factory-Made Wrought Steel Butt welding Fittings</td>
</tr>
<tr>
<td>MSS SP-75</td>
<td>Specification for High Test, Wrought, Butt Welding Fittings</td>
</tr>
<tr>
<td>MSS SP-97</td>
<td>Integrially Reinforced Forged Branch Outlet Fittings - Socket Welding, Threaded and Butt welding Ends.</td>
</tr>
<tr>
<td>IS 1239 (PART 2)</td>
<td>Steel Tubes, Tubular and Other Wrought Steel Fittings - Specification - Part 1: Mild Steel Tubular and other wrought steel pipe fittings.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stud Bolts and Nuts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A194</td>
<td>Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.</td>
</tr>
<tr>
<td>ASTM A193</td>
<td>Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications</td>
</tr>
<tr>
<td>ASME B18.2.1</td>
<td>Square and Hex Bolts and Screws, Inch Series.</td>
</tr>
<tr>
<td>ASME B18.2.2</td>
<td>Square and Hex Nuts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gaskets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.20</td>
<td>Metallic gaskets for pipe flanges: Ring joint, Spiral wind and Jacketed.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>High Pressure SS Tubing and Fittings</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pressure Safety Valve and Pressure measuring equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>API 526</td>
<td>Flanged Steel Pressure Relief Valves</td>
</tr>
<tr>
<td>BS EN 837-1</td>
<td>Pressure gauges - Part 1: Bourdon tube pressure gauges; dimensions, metrology, requirements and testing.</td>
</tr>
<tr>
<td>BS EN 837-2</td>
<td>Pressure Gauges - Part 2: Selection and Installation Recommendations for Pressure Gauges.</td>
</tr>
<tr>
<td>BS EN 837-3</td>
<td>Pressure gauges - Part 3: Diaphragm and capsule pressure gauges; dimensions, metrology, requirements and testing.</td>
</tr>
</tbody>
</table>

Filters : ASME Section VIII Boiler and Pressure Vessel Code.

Annexure- VII

"OISD hereby expressly disclaims any liability or responsibility for loss or damage resulting from the use of OISD Standards/Guidelines."
Figure-1: Present Arrangement

Figure-2: Proposed measures to be taken during repair or maintenance. Flexible copper cable/wire to be connected on the nearest succeeding & preceding flange joint through crocodile clips.

Annexure – VIII
(Clause 14.4.6)
LIST OF BASIC EQUIPMENT TO BE MAINTAINED AT BASE STATION FOR PIPELINE MAINTENANCE.

1. Truck - 1 No.
2. Tractor - 1 No.
3. Trailer - 2 wheel - 2 Nos.
4. Air Compressor - 2 Nos.
5. Jeep (large capacity) - 3/4 Nos.
7. Welding Transformer - 1 No.
15. Water Pump - 3 Nos. (5 BHP)
17. High Pressure Testing Pump - 1 No.
18. Gas Cutter, regulator, nozzle - 1 Set.
19. Dope Kettle - 1 No.
20. Aluminium Ladder - 1 No.
23. Pneumatic Pump - 1 No. (for oil recovery)
24. Bench Vice - 1 No.
25. Chain Pulley Block - 2 Ton - 1 No.
27. Pipe Lifting Clamp - 3 Nos.
29. Pneumatic Power Wrench - 1 No.
30. LP Gas Cylinder - 1 No.
34. Engine driven hydraulic Pump - 1 No.
35. Four Wheel Trailer - 1 No.
36. Four Wheel Tractor Trailer - 1 No.
37. Holiday Detector - 1 No.
38. Insulation Flange Tester - 1 No.
39. Pearson Survey and Holiday Detector - 1 No.
40. Multi meter - 1 No.
41. AVO Meter - 2 Nos.
42. Multi Combination Corrosion - Testing Meter - 1 No.
43. Emergency Generator - 1 No.
44. Tents etc for making repairing base camp with all facilities to suit the remote place.