CROSS-COUNTRY LPG PIPELINES

Prepared by

FUNCTIONAL COMMITTEE ON CROSS COUNTRY LPG PIPELINE

Oil Industry Safety Directorate
Government of India
Ministry of Petroleum & Natural Gas
8th Floor, OIDC Bhavan, Plot No. 2, Sector – 73, Noida – 201301 (U.P.)
Website: www.oisd.gov.in
Tele: 0120-2593800, Fax: 0120-2593802
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Prepared by:
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OIL INDUSTRY SAFETY DIRECTORATE
Ministry of Petroleum and Natural Gas
Government of India
8th Floor, Tower-A, OIDB Bhawan,
Plot No.2, Sector – 201 301
U.P.
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

Oil Industry in India is more than 100 years old. Over years, a variety of practices have been in vogue because of collaboration / association with different foreign companies and governments. Standardisation in design, operating and maintenance practices was hardly in existence at a national level. This lack of uniformity, coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasised the need for the industry to review the existing state of art in designing, operating and maintaining oil and gas installations.

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

The present document on “Cross-country LPG Pipelines” was prepared by the Functional Committee on ‘Cross-country LPG Pipelines’. This document is based on the accumulated knowledge and experience of functional committee members and various national and international codes and practices. This document is meant to be used as supplement and not as a replacement for existing codes and practices.

This standard in no way supercedes the statutory requirements of bodies like IBR, CCE, Factory Inspectorate or any other Government Body which must be followed as applicable.

This document will be reviewed periodically for improvements based on the new experiences and better understanding. Suggestions may be addressed to:

The Coordinator,
Committee on Cross-country LPG Pipelines,
Oil Industry Safety Directorate
Ministry of Petroleum and Natural Gas
Government of India
8th Floor, Tower-A, OIDB Bhawan,
Plot No.2, Sector – 201 301
U.P.
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These documents are intended only to supplement and not to replace the prevailing statutory requirements.
## FUNCTIONAL COMMITTEE MEMBERS

<table>
<thead>
<tr>
<th>NAME</th>
<th>ORGANISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEADER</strong></td>
<td></td>
</tr>
<tr>
<td>Sh. R. Sen</td>
<td>Indian Oil Corporation Ltd., Pipelines, Noida</td>
</tr>
<tr>
<td><strong>MEMBERS</strong></td>
<td></td>
</tr>
<tr>
<td>Sh. B. Das</td>
<td>Gas Authority of India Ltd., New Delhi</td>
</tr>
<tr>
<td>Sh. N. Rengaswamy</td>
<td>Engineers India Ltd., New Delhi</td>
</tr>
<tr>
<td>Ms. Ketaki Adhikary</td>
<td>Engineers India Ltd., New Delhi</td>
</tr>
<tr>
<td>Sh. B.S. Giridhar</td>
<td>Indian Oil Corporation Ltd., Mumbai</td>
</tr>
<tr>
<td>Sh. N. Dasgupta</td>
<td>Bharat Petroleum Corporation Ltd., Mumbai</td>
</tr>
<tr>
<td>Sh. G. S. Wankhede</td>
<td>Bharat Petroleum Corporation Ltd., Mumbai</td>
</tr>
<tr>
<td>Sh. Dev Raj</td>
<td>Bharat Petroleum Corporation Ltd., New Delhi</td>
</tr>
<tr>
<td>Sh. P. S. Murthy</td>
<td>Hindustan Petroleum Corporation Ltd., Mumbai</td>
</tr>
<tr>
<td>Sh. S.C. Gupta</td>
<td>Oil Industry Safety Directorate, New Delhi</td>
</tr>
<tr>
<td><strong>MEMBER CO-ORDINATOR</strong></td>
<td></td>
</tr>
<tr>
<td>SH. S. K. NANDY</td>
<td>Oil Industry Safety Directorate, New Delhi</td>
</tr>
</tbody>
</table>
# CROSS-COUNTRY LPG PIPELINES

## CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>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>1-2</td>
</tr>
<tr>
<td>3.0</td>
<td>DEFINITION</td>
<td>2-5</td>
</tr>
<tr>
<td>4.0</td>
<td>STATUTORY RULES / REGULATIONS</td>
<td>6</td>
</tr>
<tr>
<td>5.0</td>
<td>DESIGN</td>
<td>6-14</td>
</tr>
<tr>
<td>6.0</td>
<td>INSTALLATION LAYOUT</td>
<td>15</td>
</tr>
<tr>
<td>7.0</td>
<td>CORROSION CONTROL</td>
<td>16-21</td>
</tr>
<tr>
<td>8.0</td>
<td>MATERIALS AND SPECIFICATIONS</td>
<td>22-23</td>
</tr>
<tr>
<td>9.0</td>
<td>FLANGE JOINTS, BOLTS, NUTS, GASKETS OR OTHER FITTINGS</td>
<td>23-24</td>
</tr>
<tr>
<td>10.0</td>
<td>CONSTRUCTION, WELDING &amp; ASSEMBLY</td>
<td>24-29</td>
</tr>
<tr>
<td>11.0</td>
<td>TESTING AND COMMISSIONING</td>
<td>29-33</td>
</tr>
<tr>
<td>12.0</td>
<td>INTERFACE BETWEEN PIPELINE OPERATOR &amp; CONSUMER TERMINALS</td>
<td>33-35</td>
</tr>
<tr>
<td>13.0</td>
<td>SAFETY &amp; FIRE PROTECTION SYSTEM</td>
<td>35-42</td>
</tr>
<tr>
<td>14.0</td>
<td>EMERGENCY PREPAREDNESS</td>
<td>42-45</td>
</tr>
<tr>
<td>15.0</td>
<td>PIPELINE OPERATION &amp; MAINTENANCE</td>
<td>45-50</td>
</tr>
<tr>
<td>16.0</td>
<td>PIPELINE INTEGRITY MANAGEMENT</td>
<td>50-52</td>
</tr>
<tr>
<td>17.0</td>
<td>REFERENCES</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>SECIFICATIONS OF LPG</td>
<td>54-55</td>
</tr>
<tr>
<td>18.0</td>
<td>ANNEXURES</td>
<td>56-66</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION:

Liquefied Petroleum Gas (LPG) due to its inherent properties is susceptible to fire, explosion and other hazards. Such hazards can have an impact on the property, equipment, plant personnel and public. Transportation of LPG through pipeline has become a preferred mode over conventional modes such as road / rail, being safer and environment friendly.

The primary purpose of this standard is to establish norms for safety in design, materials, construction, inspection, testing, operation and maintenance of cross country LPG Pipelines and also for protection of employees, public and facilities against the hazard associated with transportation of LPG Pipeline system.

2.0 SCOPE:

This standard outlines the minimum requirement for safety in design, construction, inspection, testing, commissioning, operation, maintenance, of onshore cross country LPG Pipelines. This standard also includes specific safety requirement for interface between pipeline dispatch terminal and receiving unit i.e. LPG Bottling Plant, Bulk dispatch unit etc.

This standard is applicable to pipeline facilities as per Scope Outline Sketch enclosed as Annexure I.

This standard does not cover the design and facilities associated with LPG Bottling Plant, Other Plant requiring LPG and Bulk Storage which is covered in OISD-STD-144.

This standard outlines the minimum requirements for design, materials, construction, assembly, inspection, testing, commissioning, operation, maintenance, modifications, corrosion protection and safety aspects of cross country Liquefied Petroleum Gas (LPG) and high vapour pressure hydrocarbon in liquid form (C2 – C3, C3, Ethylene etc.) pipelines on shore, offshore section of a predominately onshore pipeline (such as creek /estuary crossings), feeder pipelines from Jetty and spur / branch pipelines transporting LPG between Storage points, terminals (marine, truck and rail) and other delivery and receiving points. This standard also includes specific safety requirement for interference between pipeline dispatch terminal and receiving unit i.e., LPG Bottling plant, Bulk dispatch unit etc.,

Notes:

1. Cross country Pipeline transporting Liquid (crude / petroleum products) are covered in OISD-STD-141.

2. Natural Gas transmission pipelines are covered in OISD-STD-226 (Part-I).

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 pipeline 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.

3.0 DEFINITION:

All definitions pertains to this standard only:

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

Area Classification: It is a method of classifying an area zone wise / group wise based on the presence of explosive gas / vapour – air mixture vis-à-vis the requirement precautions for construction and use of electrical apparatus.

Bonding: Bonding is the process by which two electrical conducting bodies are connected using a conductor to maintain electrical continuity to prevent sparking between two conducting bodies.

Cross country pipeline: Cross country pipeline means all pipeline located beyond the boundary of any facility and its associated facilities which are required for transportation of LPG from one point to another excluding piping within the Refineries, separation and / or gas processing plant up to plant isolation valves.

Consumer Company: The company or organization to whom LPG is delivered from the cross country pipeline owned and operated by a company (called supplier company) for further use or movement.

Explosive mixture: It is the mixture of combustion agent (oxidizing product- gas, vapour, liquid or solid) and a fuel (oxidisable product- gas, liquid or solid) in such a proportion that it could give rise to a very rapid and lively oxidation reaction liberating more energy than is dissipated through conduction and convection.

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.

Fire Safe: As applied to valves, it is the concept of controlling leakage to an acceptable level after damage encountered during and after the fire achieved by dual seating.

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Flammability: It is the percentage of volume of any flammable vapour in air- vapour mixtures capable to form an explosive mixture.

Gas- Free: Means the concentration of flammable or toxic gases or both in a pressure vessel or pipeline is within the safe limit specified for persons to enter and carryout hot work in such vessels / pipelines.

Hot work: It is an activity which may produce enough heat to ignite a flammable air-hydrocarbon mixture or a flammable substance.

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.

Intermediate Delivery station: An intermediate delivery station on the pipeline is an installation having facility to deliver product to any consumer(s) through a tapping from the main pipeline. Delivery can be through full cut or heart cut.

Intermediate Pigging Station: An intermediate pigging station is an installation having facility for receiving and launching of pigs for pipeline cleaning operation.

Liquid Petroleum Gas (LPG): LPG is a mixture of light hydrocarbons, primarily C3 & C4 derived from crude oil or crude oil equivalent, which is gaseous at ambient temperature and atmospheric pressure, is liquefied at ambient temperature with application of moderate pressure. The specification of LPG will be governed by IS: 4576 / IS: 14861 (Enclosed for reference).

LPG Pipeline system: All facilities including the pipeline associated with transfer of LPG defined in para 2.0.

Onshore - Areas other than Offshore as defined below, forming the scope of this standard. Feeder lines from Jetty or other storage point and spur lines will form part of onshore pipeline.

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.

Odorization: LPG has only a very faint smell, therefore, ethyl mercaptan is normally used as stanching agent for identifying the leakage as per IS:4576.

Pump Stations:
Originating pump station: An originating pump station is the first installation having facilities such as booster pumps, mainline pumps etc. for boosting the pressure of the liquid to be transported so that it reaches to next station.

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Intermediate pump station: An intermediate pump station is any installation having facilities such as pumps etc. between originating pump station and terminal / final / last delivery station on the pipeline for boosting the pressure of the liquid so that it reaches to next station.

Purging: It is the act of replacing the atmosphere within a container by an inert substance in such a manner as to prevent the formation of explosive mixture.

Shall: The word ‘shall’ is used to indicate that the provision is mandatory.

Should: The word ‘should’ is used to indicate that the provision is recommendatory as per sound engineering practice.

Supplier Company: The company or organization owning and operating LPG pipeline system for delivering to various consumer company.

Terminal / Final Station: Terminal station is the last station on the pipeline used for delivery of product to consumer(s) through full cut only.

Vapour Pressure of LPG: Pressure exerted by saturated vapour of LPG in a closed container or system at working temperature. As per IS 4576 LPG can have maximum vapour pressure of 14.5 Kg/ Cm² at 55⁰ C and 16.87 Kg/ Cm² at 65⁰ C.

Chief Controller
Means Chief Controller of Explosives.

Competent Authority
Any person authorized by Central Government, by notification in the official Gazette, to perform the functions of the competent authority under the PMP Act’1962.

Competent Person:
A person recognized by the concerned statutory authority for the purpose in respect of which the competency is required.

Custody transfer meter: A gas measuring device which measures the quantity and / or energy of gas delivered from one agency to another agency for transfer of custody.

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

High Vapour Pressure system: The pipeline system conveying hydrocarbon or hydrocarbon mixture in liquid or quasi liquid state with a vapour pressure more than 110 kpa (abs) at 38 degree Celsius determined by Reid

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method.

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

**Nominal Pipe Size**
It indicates the standard pipe size when followed by a number. (e.g. NPS ¼, NPS 10, etc.,).

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

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

**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.

**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.

**Right of Use / Right of Way**
The area or portion of land within which the pipeline operator or owner or 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 pipeline.

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

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

**Sectionalizing Valve (SV)**
Valves (MOVs / HOVs) used in cross country pipeline system for isolation of particular pipeline section whenever required. This valve is also referred to as Main Line Valve (MLV).
4.0 STATUTORY RULES / REGULATIONS:

LPG pipeline and its associated facilities are covered under various regulations and require specific approval from concerned authorities. Various regulations applicable are as follows:

(i) Petroleum and Natural Gas Regulatory Act’2006.
(iii) Environmental Regulations:
   b. The Environment (Protection) Act -1986
   d. Air (Prevention & Control of Pollution) Act 1981
   e. Manufacture, storage & import of Hazardous chemical Rules-1989

(v) Indian Electricity Rules.
(vii) National Highways Act, 1956
(viii) Railways Act, 1989
(ix) All other statutory approvals required for laying of the pipelines across rail, road and river crossings.

5.0 DESIGN:

5.1 PIPELINE SYSTEM:

Design of LPG pipeline system shall be in accordance with ANSI / ASME B 31.4. 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.

A detailed 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.

5.1.1 Other Loadings:
Unusual loadings such as those caused by scour, erosion, soil movement and slides, installation forces, vortex shedding and other phenomena shall be considered and provided for in accordance with sound engineering practice.

5.1.2 Weight Effects
Live Loads:

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Weight of water during hydrostatic testing shall also be considered.

5.1.3 Design temperature:

Appropriate temperature range for design of pipeline / piping system shall be determined based on temperature of product (LPG or high vapour pressure hydrocarbon in liquid state proposed to be transported through the pipeline, ambient / sub-soil temperature and type of anti-corrosion coating to be used.

Maximum Temperature:
Maximum temperature for design of above ground section of pipeline / piping shall be maximum expected product temperature during operation or maximum ambient temperature whichever is higher.

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

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

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

5.2 DESIGN OF COMPONENTS:

5.2.1 STRAIGHT PIPE:

Pipe having D/t ratio greater that 100 shall not be used. Where D= outside diameter and t = least nominal wall thickness.

Section(s) of cross country liquid pipeline to be installed across estuaries and creeks etc. affected by tidal fluctuation, waves and currents and cannot be installed using conventional onshore equipment should be designed in accordance with Det Norske Veritas (DNV) Standard FS-101/ OISD-Std-139.

The least nominal wall thickness (tₙ) for the steel pipe, shall be as per ASME B 31.4. Wall thickness ‘t’ for straight steel pipe under internal pressure shall be calculated by the following equation:

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

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where \( D \) = outside diameter of pipe.
\[ P_i = \text{Internal Pressure} \]

The allowable stress value \( S \) to be used for design calculations for new pipe of known specifications shall be established as follows:

\[ S = 0.72 \times E \times \text{Specified minimum yield strength of pipe.} \]

Where,

\[ 0.72 = \text{Design factor based on nominal wall thickness. In setting design factor, due consideration has been given to and allowance has been made for the under thickness tolerance and maximum allowable depth of imperfection provided for in the specification approved by code.} \]

\[ E = \text{Longitudinal joint factor, which for High Frequency electric resistance welded (HFERW), longitudinal seam submerged arc welded (LSAW), helical seam submerged arc welded (HSAW) and seamless types of pipes, manufactured in accordance with API specification 5L and considered as 1} \]

### 5.2.2 CORROSION:

All underground and above ground pipes and its components shall be fully protected against corrosion. A wall thickness allowance for corrosion is not required if pipe and component are protected against corrosion.

### 5.3 ADDITIONAL REQUIREMENT:

#### 5.3.1 Sectionalizing / Block valves
with remote shut off provision from the control room shall be provided at the boundary of station pipeline inlet and outlet locations to isolate the station facility.

#### 5.3.2 Check valves
should be installed to provide automatic blockage of reverse flow in the piping system, within the station wherever required.

#### 5.3.3 Remotely operated Sectionalizing / Mainline block valve(s)
shall be provided with blow down connection to isolate the pipeline section and evacuate the pipeline section in case of emergency and repair. All blow down piping shall have double valve segregation. Mainline sectionalizing / block valves shall be installed at maximum spacing of 12 KM in industrial, commercial and residential areas. Block valves shall be installed on upstream and downstream of major water crossings and public water supply reservoir.

Major water crossings 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 water mark to high water mark).

5.3.4 The number of flanged or threaded joints for station piping shall be to the extent minimum.

5.3.5 No free water in LPG being pump shall be allowed as per IS 4576. Online water analyser may be installed at the originating pump station to detect any free water in the LPG being pumped.

5.4 PIPELINE SYSTEM & COMPONENTS:

5.4.1 Piping shall be designed for handling LPG. Piping that can be isolated and need thermal safety valves shall have minimum design pressure of 24 kg/cm² or maximum pressure which could be developed by transfer equipment or any other source etc. whichever is higher.

5.4.2 Low point drains and high point vents shall be plugged or capped suitably.

5.4.3 LPG Pumps:

i. LPG Pumps shall conform to API 610.
ii. LPG Pumps shall be provided with suction and discharge pressure gauges.
iii. A high point vent to safe height minimum 3 M above the pump in case of no pump shed or 1.5 M above the pump house roof top or connected to a cold flare with flame arrester.
iv. Check valves shall be installed on discharge side of all centrifugal pumps. Suction and discharge side of the main pumps and booster pumps shall have actuated valves.
v. Minimum flow circulation line for bypass shall be provided for booster pumps / main pumps in line with manufacturer’s recommendations.
vi. Pumps protection and interlocks shall be provided in accordance with manufacturer's recommendations.
vii. Seal with seal failure alarms and trips shall be provided. Mechanical seals, if provided, shall be double mechanical type.
viii. Following alarms and tripping shall be provided on pumps:
   a. Low suction pressure of booster and main pump.
   b. High discharge pressure at main pump
   c. Low discharge pressure trip to avoid liquid vaporization.
   d. High Casing temperature
   e. High bearing temperature
   f. Tripping of main/booster pump in case of closure of suction / discharge valves.

ix. Design shall take care of abnormal and emergency situations.
x. Suction and discharge valves limit switch position (open /close) to be interlocked with the start of the pump.
xi. Pump shall operate in sequence with defined logic at starting and shut down.
5.4.5 Pump Drivers:

5.4.5.1 Electric Motors with fixed speed drive or variable frequency drive (VFD) may be, when provided as pump drivers, shall meet the requirement of API Standard 540 "Electrical Installation of Petroleum Processing Units.

5.4.5.2 When Internal Combustion Engines as pump drivers are provided, this shall meet the requirement of API standard 7C - 11F - "Recommended practice for Installation, Maintenance and Operation of Internal Combustion Engines" or suitable BIS equivalent codes.

5.4.6 Bends, Fitting and Pipe Support at Station:

5.4.6.1 Mitre bend with maximum 12.5 degree bend can be used if the system is intended to operate less than 20% of SMYS. In case the system is designed to operate at a hoop stress of more than 20% of specified minimum yield strength (SMYS), mitre bend shall not be permitted.

5.4.6.2 Sleeve, coupled, and patented joints shall not be used on LPG Pipelines.

5.4.6.3 Pipe Support:

Supports and anchors shall be fabricated from suitable materials. Supporting elements required to be welded to the gas piping shall comply with the following:

(i) If the gas piping is designed to operate at a hoop stress of less than 20% of SMYS, supports or anchors shall be directly welded to the pipe.

(ii) If the pipe is designed to operate at a hoop stress level of 20% or more of SMYS, support element are not permitted to be welded directly to the pipe. Support elements shall be welded to a separate cylinder member that completely encircles the pipe. Encircling member shall be welded to the pipe continuously and cover the entire circumference.

5.4.7 Valves:

Valves shall be installed buried and provided with a stem extension in such a way that the centre of 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.
5.4.8 Pressure Relief Valves:

Pressure Relief Valves shall meet the requirement of API 520 "Sizing, Selection and Installation of Pressure Relieving Devices in Refineries" / OISD-STD-106 or equivalent.

5.4.9 Scraper Trap:

5.4.9.1 Quick Opening Closures system shall be used for Trap in order to provide repeated access to the interior of piping system.

5.4.9.2 The closure system shall meet the minimum requirement of API 6H “End Closures, Connectors & Swivels”

5.4.10 Strainer / Filter:

5.4.10.1 The strainer/ filter housing shall be designed as per Section VIII division of ASME Standard: (For Boiler and Pressure Vessel).

5.4.10.2 The free area of strainer shall not be less than three times the cross section area of suction line.

5.4.11 Communication:

A reliable and dedicated communication system to interact between all stations including sectionalizing valve stations across the entire pipe line shall be designed and installed and maintained to ensure safe operations under both normal and emergency situations.

5.4.12 Instrument and Control System:

5.4.12.1 Instrumentation and control system for the Pipeline system in totality shall meet the requirement as per API Standard 550 "Manual on Installation of Refinery Instruments and Control Systems."

5.4.12.2 The control system to be provided in the supply & receiving stations shall be developed based on study & analysis in entirety, keeping in view the pipeline quantity transported and its maximum variations.

5.4.12.3 Flow / Pressure Control Valve
Design of control valves shall meet the requirement of part I of API 550.

5.4.12.4 For liquid metering, positive displacement meters, turbine meters, Mass flow meter or equivalent liquid measuring devices and their proving facilities shall be designed and installed in accordance with the API Manual of Petroleum Measurement Standards or equivalent.

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5.4.13 Electrical Installations of Pipeline Station:

5.4.13.1 Area Classification of Pipeline Installation, as basis for Selection of Electrical Equipment for LPG Pipeline Station shall follow IS –5572 and OISD 113 on “Classification of area for electrical installations at hydrocarbon processing and handling facilities”.

5.4.13.2 The specification of Electrical equipment shall be in line with IS: 5571, ‘Guide for selection of Electrical Equipment for Hazardous Area.’

5.4.13.3 Safety in electrical system to be designed as per OISD-RP-149.

5.4.13.4 All electrical equipment, systems, structures and fencing shall be suitable earthed conforming to IS 3043. The earthing system shall have an earthing network grid with required number of electrodes.

5.4.13.5 All Electrical equipment operating above 250 volts shall have two separate and distinct connection to earth grids.

5.4.13.6 Fire protection in Electrical installations shall be designed as per OISD-STD-173.

5.4.13.7 Safety devices in line with NACE-RP-01-77 shall be installed for preventing the damage to the pipeline due to lightning or fault currents when the pipeline is installed near electric transmission tower footings, ground cables etc.

5.4.14 Piping Requirement for Refrigerated LPG transfer:

5.4.14.1 Piping system shall be designed as per ASME B 31.3. The refrigeration system shall maintain the LPG at a temperature at which LPG’s vapour pressure does not exceed the piping design pressure.

5.4.14.2 Pipe component material specification should meet the temperature extremes for which it has been designed. Low ductility materials such as cast iron, semisteel, malleable iron and cast aluminium shall not be used in any pipe.

5.4.14.3 Shut of valves and accessory equipment shall be constructed of material suitable for operating pressure and temperature extremes to which they are subjected.

5.4.14.4 The insulation shall contain a vapour barrier and shall be weather proofed. Insulation and weather proofing shall be fire retardant. Steel surfaces covered by insulation shall be properly coated to prevent corrosion.

5.4.14.5 When cold piping is routed below ground provision like trenches, casing and other

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means shall be made to permit expansion and contraction of the pipeline.

5.4.14.6 When storage facility handles more than one type of product, dedicated loading and unloading pipelines shall be considered for each type of product.

5.4.14.7 The vapour load resulting from refrigeration shall be handled by one or a combination of the following method:

(a) Recovery by a liquefaction system
(b) Disposal by flaring

5.4.14.8 Provision shall be made for emergency alarm to signal excess pressure build up in the pipeline because of a failure of cooling medium.

5.5 DESIGN OF LPG SAFETY SYSTEM:

5.5.1 PRESSURE LIMITING DEVICES:

A weep hole with nipple at low point shall be provided on the vent pipe in order to drain the rain water which may get accumulated otherwise. Weep hole nipple shall be so oriented that in case of safety valve lifting and consequent fire resulting from LPG coming out from weep hole does not impinge on the structure or equipment. A loose fitting rain cap with chain (non sparking) shall be fitted on top of the vent pipe.

5.5.1.1 THERMAL RELIEF VALVE (TRV):

Any equipment or section of pipeline containing liquid LPG in the form of trapped volume shall be protected against excessive pressure developed due to rise in surrounding temperature by installing TRVs. The discharge of TRVs shall be connected to flare or vent system wherever available. All TRVs shall have lock open type isolation valve upstream of relief valve. In addition lock open isolation valve downstream of relief valve shall be provided if vent is connected to flare header.

PRESSURE SAFETY VALVE (PSV):

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 to 10% of MAOP, whichever is less. The discharge of PSVs shall be connected to flare or vent system wherever available.

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5.5.2 DELIVERY STORAGE:

High level alarm and High level alarm indication of storage vessel shall be set at 80% and 85% level of volumetric capacity respectively. The audio visual indication shall be provided at local panel and the pipeline control room. Pipeline delivery ROVs (supplier’s and consumer’s premises) shall close on actuation of high high level alarm.

5.5.3 PROTECTION OF FACILITIES:

5.5.3.1 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.

5.5.3.2 Proper industry type boundary wall at least 3 M high with 0.6 M barbed wire on top shall be provided all around the installation i.e. pump station / intermediate station / delivery station / terminal station provided unless the installation is protected as part of refinery / bulk delivery / LPG installation in line with MHA (Ministry of Home Affairs) guidelines.

5.5.3.3 Emergency exit with proper gate shall be provided in the earmarked zone.

5.5.3.4 In case provision for green belt is made, the same shall be segregated from hazardous area by 1 M high wall / chain link fencing. Alternatively, it shall be treated as a part of hazardous area.

5.5.3.5 LPG pipeline system shall be equipped with following:

   (1) Supervisory Control and Data Acquisition (SCADA).
   (2) Leak detection system with provision for identification / location of leak and isolation of affected section.
   (3) Facilities for controlled flaring.
   (4) Accessories & kit for arresting leak.

5.5.4 VENTS:

(a) In case of non-availability of flare system, the discharge from safety valve shall be vented vertically upwards to atmosphere at an elevation of 3 meter (minimum) above working level or the tallest structure within a radius of 15 meter whichever is higher for effective dispersion of hydrocarbons. In this case, isolation valves on down stream of PSVs are not required.

(b) A weep hole with nipple at low point shall be provided on the vent pipe in order to drain the rain water which may get accumulated otherwise. Weep hole nipple shall be so oriented that in case of safety valve lifting and consequent fire resulting from LPG coming out from weep hole does not impinge on the structure or equipment. A loose fitting rain cap with chain (non sparking) shall be fitted on top of the vent pipe.

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6.0 INSTALLATION LAYOUT:

6.1 LOCATION:

The information on following aspects are required to be considered for finalising location of pipeline station.

i. Location of storage facilities to hook up with LPG pipeline system at upstream and downstream side.
ii. Findings of Risk Analysis (RA) study for the pipeline stations including plan for emergency measures.
iii. Adequate availability of water from a reliable source or alternative arrangement available / proposed.
iv. The availability of space for future augmentation of facilities keeping in view of complying safety norms.

6.2 LAYOUT:

The following aspect shall be considered while establishing station layout:

i. Pipeline installation shall be located upwind of LPG bulk storage facilities.
ii. Main power receiving station, comprising of HT pole structure, Transformers, Breaker & PMCC rooms etc. shall be located in non-hazardous area. Overhead power lines shall not pass over licensed area.
iii. The accessibility of mobile firefighting equipment to LPG pumps and other station equipment.
iv. Due care shall be taken to avoid accumulation of LPG vapour in low lying areas / pits.
v. Station equipment and their specification.
vi. P&I diagram for the station.
vii. Utility requirement.
viii. Flares.
ix. Operation & maintenance philosophy of station equipment.
x. Fire station & allied facility.

6.3 Sub-station:

The Sub-station’s location / layout should be in line with OISD-RP-149.

6.4 Separator Distances:

Inter-distances for various station facilities and utilities shall be as per Annexure- II.
7.0 CORROSION CONTROL:

7.1 GENERAL:

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

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

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

7.1.4 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.

7.1.5 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.

7.1.6 Insulating joints shall also be installed at the following locations.

(a) Where pipeline/ structure changes ownership such as metering station.
(b) Connecting point of two pipelines / structures having different external coating / CP.
(c) Junction of branch lines having dissimilar metal.

7.1.7 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.

7.1.8 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.

7.2 EXTERNAL CORROSION:

7.2.1 External coating for buried pipeline: Pipelines should be designed considering the

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OISD – STD – 214
CROSS COUNTRY LPG PIPELINES

possible corrosive effects of industrial waste, ground, parallel encroachments to high voltage overhead AC power lines and stray DC earth currents. Anticorrosion coating shall be selected reflecting the varying ground conditions found during soil resistivity survey carried out along the pipeline route. Coating shall be selected based on following criteria.

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.

7.2.2 Cathodic Protection System:

In addition to protective coating, buried pipelines shall also be provided with cathodic protection system.

a) During construction period pipeline shall be protected by temporary sacrificial anode based cathodic protection system.

b) Permanent Cathodic protection system shall be brought into operation as soon as possible following pipeline construction.

c) Sacrificial anode or impressed current cathodic protection system shall be installed to mitigate the corrosion in the pipelines. The system shall have facilities for measuring the degree of cathodic protection achieved.

d) It shall be ensured that continuous power supply is maintained in cathodic protection system.

e) Cathodic protection shall be such that it does not damage the protective coating, pipe or components.

f) Sufficient test leads points (TLPs) shall be installed on pipeline for taking electrical measurements to indicate adequacy of the CP system.
7.2.3 Coating Specifications:

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);
(c) Properties of base materials;
(d) Properties of as-applied coating;
(e) Operating temperature range which the coating must withstand without deterioration of its physical and electrical properties;
(f) Minimum surface preparation and coating application requirements;
(g) Adhesion requirements for materials, application and curing, including possible requirements for health, safety and environmental aspects;
(h) Inspection and Testing requirement;
(i) Repair of damaged coating at site for field repair.

7.2.4 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.

7.2.5 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).

7.2.6 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.

7.3 Cathodic Protection System:

7.3.1 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.

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7.3.2 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.

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

7.3.4 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.

7.3.5 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 sectionalizing 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.

7.3.6 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 equipotential level for all pipelines in the same ROW thus ensuring no net flow of protective current from one to other co-existing pipelines.

7.3.7 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.

7.3.8 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.

7.4 Electrical Interference Mitigation:

After installation of Permanent CP system, an 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.

7.4.1 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.

7.4.2 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.

7.4.3 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.

7.4.4 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.

7.4.5 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.

7.4.6 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.
7.4.7 It is required to provide shorting link across any metallic 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 –X).

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

7.5 **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.

7.6 All Sectionalizing Valves and Motor Operated Valves 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 earthing.

7.7 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.

7.8 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.

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8.0 MATERIALS AND SPECIFICATIONS:

8.1 The flange joint shall be either spiral wound metallic gaskets or ring joints. Plain asbestos sheet / reinforced gaskets shall not be used. Gaskets used shall confirm to ANSI B 16.20 or equivalent. Flange connection ratings shall match with the design pressure of the pipeline (on high pressure side) and in no case shall be less than 300 series rating (low pressure side) confirming to ANSI 16.5 or equivalent. All tapping or opening shall be minimum 20 mm dia. The materials used shall conform to ASME B 31.4 or equivalent.

8.2 Line pipe for use in LPG Pipeline System shall be Seamless, High Frequency Electric Resistance Welded (HFERW) or Longitudinal/ Helical Submerged Arc Welded (LSAW/ HSAW) conforming to Line Pipe Specification API 5LProduct Specification Level 2 (PSL 2) or equivalent.

Pipes made of Cast iron are not permitted to be used for transportation of LPG.

8.3 Carbon Equivalent:

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

\[
\text{CE (Pcm)} : 0.20 \\
\text{CE (IIW)} : 0.40
\]

Carbon Equivalent shall be calculated based on the formula given below:

For Carbon content less than or equal to 0.12%,

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

If heat analysis indicate that boron content is less than 0.01%, then product analysis need not include boron.

For Carbon content more than 0.12%,

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

8.4 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 seconds.
8.5 Notch Toughness Requirements :

For Carbon Steel pipes and other steel components of size 2” NPS and larger, Notch toughness values shall be determined to provide protection against fracture initiation and propagation. Notch toughness values (minimum absorbed impact 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 2” NPS proven notch toughness properties are not mandatory.

8.6 Fracture Toughness :

Carbon steel line pipes shall meet the fracture toughness requirements stipulated in ASME B 31.4.

8.7 High integrity ball, plug and check valves suitable for LPG services shall be provided. All valves shall be in accordance with API-6D or equivalent. All valves shall meet the fire safe requirement of API 607.

8.8 The remote operated valves connecting pipeline to storage vessel shall be fire safe type conforming to API 607 or equivalent.

8.9 Branch Connections :

Branch connections of size below NPS 2 are not recommended in buried pipeline section.

All branch connections from mainline shall be provided with an isolation valve located at a minimum possible distance from the main pipeline.

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.

9.0 FLANGE JOINTS, BOLTS, NUTS, GASKETS OR OTHER FITTINGS :

The number of flanged joints in station piping shall, to the extent, be kept minimum. Flanges shall conform to ANSI 16.5 or ASME B 16.47 Series A or MSS-SP 44 or equivalent.

The flange joint shall have either spiral wound metallic gaskets or ring joints. Plain asbestos sheet / reinforced gaskets shall not be used.

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Threaded joints shall not be used on LPG Pipelines except for instrument tapping. The dimensions of all piping connection threads, not otherwise covered by a governing component standard or specification, shall conform to the requirements of ASME B 31.4 (Chapter IV) or equivalent.

The flanged joint shall have either spiral wound metallic gaskets or metallic ring type gaskets. Plain asbestos sheet / reinforced gaskets shall not be used.

Pipes and fitting manufactured to standards listed in Annexure- IX of this standard should be used.

10.0 CONSTRUCTION, WELDING, AND ASSEMBLY :

10.1 All safety precautions during construction shall be followed as specified in OISD-GDN 192, OISD- STD-147 and API RP 1102.

10.2 All provisions of OISD-STD-141 of Para 11.4 and 11.5 shall apply.

**Ditching**

While arriving at the Depth of the ditch, due consideration will be given to the route, location, surface use of the land, terrain features and loads imposed by road / railway. All buried pipelines shall be installed below the ground level in line with the “Minimum Cover for Buried Pipelines”, as specified in Table 10.2.1

<table>
<thead>
<tr>
<th>Location</th>
<th>Minimum Cover in meter (Ref note)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial, Commercial &amp; Residential areas</td>
<td>1.2 (2)</td>
</tr>
<tr>
<td>Streams, Canals &amp; minor water crossings</td>
<td>1.5 (4)</td>
</tr>
<tr>
<td>Drainage ditches at roadways &amp; railways</td>
<td>1.2 (2)</td>
</tr>
<tr>
<td>Rocky areas</td>
<td>1.0 (2,5)</td>
</tr>
<tr>
<td>Uncased / Cased Road crossings</td>
<td>1.2 (3)</td>
</tr>
<tr>
<td>Railway crossings</td>
<td>1.7 (3)</td>
</tr>
<tr>
<td>River crossings (below scour level)</td>
<td>2.5 (6)</td>
</tr>
<tr>
<td>Other areas</td>
<td>1.2 (2)</td>
</tr>
</tbody>
</table>

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Note:

(1) The above mentioned minimum cover requirements shall be valid for all class locations.

(2) Minimum depth of cover shall be measured from the top of pipe coating to the top of undisturbed surface of the soil, or top of graded working strip, whichever is lower. Fill material in working strip shall not be considered to add to the depth of cover.

(3) Cover shall be measured from the top of road or top of rail, as the case may be.

(4) In case of rivers/water bodies, which are prone to scour and erosion, adequate safe cover (minimum 1.5 metre) shall be provided below the predicted scour profile expected during the life time of the pipeline.

(5) Soft soil / sand padding of minimum 150 mm thickness to be provided around the pipe in rocky areas.

(6) For river /water bodies which are prone to scour and erosion, adequate safe cover shall be provided below the predicted scour profile expected during the life time of the pipeline.

Good pipeline practices shall be followed for public safety. In case the pipeline is to be laid through populated area (which otherwise could not be avoided), additional protective measures to be provided be by way of providing higher wall thickness pipe or laying at a greater depth or by providing casing pipe.

10.3 DEFECTS IN PIPE:

(i) All defects in pipe shall be removed in line with ASME B 31.4, API 5L or equivalent.

(ii) Notches or laminations on pipe ends shall not be repaired. The damaged portion shall be removed as a cylinder and re-bevelled to the piped properly.

(iii) Distorted or flattened lengths shall be discarded.

(iv) 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.

(v) All dents which affect the curvature of the pipe at the seam or at any girth weld shall be removed as in ASME B 31.4.

(vi) Buckled pipe shall be replaced as a cylinder.

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10.4 Bends, Mitres & Elbows:

10.4.1 To match the contours of the ditch in the event of change in direction, sagging, over bending etc., the required fittings shall be made either by bending the pipe or factory made bends or elbows shall be used. The pipe diameter shall not be reduced at any point by more than 2-½ % of the nominal diameter, and the completed bend shall pass the specified sizing pig. Mitred bends are not permitted in mainline. Factory made bends of not less than 3D are permitted.

The minimum radius of field cold bends shall be as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe size In</th>
<th>Minimum Bend Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS 12 and smaller</td>
<td>18D</td>
</tr>
<tr>
<td>NPS 14</td>
<td>21D</td>
</tr>
<tr>
<td>NPS 16</td>
<td>24D</td>
</tr>
<tr>
<td>NPS 18</td>
<td>27D</td>
</tr>
<tr>
<td>NPS 20 and larger</td>
<td>30D</td>
</tr>
</tbody>
</table>

Where, “D” is the outside dia of the steel pipe.

10.4.2 Pipes with measured wall thickness greater than the nominal wall thickness (with positive tolerance) should normally be used for making cold field bends.

10.4.3 The ends of each bend length shall be straight and not involved anyway in the bending. In no event shall the end of the bend be closer than 0.5 m or equal to pipe diameter whichever is small from the end of a pipe or within one meter of a girth weld. The ovality in each pipe after bending shall be less than 2.5 percent of the nominal diameter, at any point.

10.4.4 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 300 mm apart or pipe nominal diameter whichever is larger.

10.4.5 Pipes with longitudinal welds shall be bend in such a way that weld lies in 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.

10.4.6 Cold bend pipes on site shall have the corrosion coating carefully checked with the aid of a holiday detector for cracks in the coating down to the pipe wall. Any defects or
disbonding of the coating caused during bending (including forced ridges in the coating) shall be repaired.

10.5 WELDING:

10.5.1 General:

(a) Standard of acceptability for welding process, filler materials, and weld quality shall conform to be API-1104.

(b) Safe Practices in Cutting and Welding shall be ensured with safety work permits as per OISD-STD-105.

10.5.2 Welding Qualifications:

(a) Welding procedures or welders shall be qualified in line with under API 1104, or section IX of the ASME Boiler and Pressure Vessel Code, whichever is appropriate for the type of welding to be performed.

(b) Qualification Records: Records of the tests that establish the qualification of a welding procedure shall be retained as long as that procedure is in use.

(c) A record of the welders’ qualification test, showing the date and results of the tests, shall be retained during the construction involved and for 6 months thereafter.

10.5.3 Welding Inspection and Acceptance Criteria:

(a) The quality of all weld joints shall be checked by visual inspection and supplemental non-destructive testing (NDT) methods or by removing completed welds as selected for destructive testing (DT).

(b) All the girth welds (completely around pipe circumference) i.e., 100% weld joints shall be inspected by radiography.

(c) 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.,

(d) The Non-destructive inspection method used shall produce indications of potential defects, which can be accurately interpreted and evaluated. All NDT including Radiographic examination and destructive method of examination shall be performed in accordance with the requirements of API 1104.
10.6 CROSSINGS:

As far as practicable, crossings shall be made at right angles. Turning Points (TPs) provided near crossings shall be located at least 50 m from the boundary of the crossings, on stable and firm ground except for the stretches which runs parallel to road.

Minimum cover shall be as per Para 10.2

10.6.1 RAIL AND ROAD CROSSINGS:

The angle of crossings for national and state highways shall be as close to 90 degrees as possible, but in no case less than 80 degrees to the centre line of the road/highway. The angles of crossing for other roads (like seasonal roads, unpaved village roads, cart-tracks, etc.,) should be as close to 90° as possible.

The angles for all railway crossings shall be as close to 90 degrees as possible, but in no case less than 85 degrees to the centre line of the railway line.

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

Casing pipe shall be as installed as per requirements of the railway authorities.

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. Carrier pipe shall be adequately supported inside casing pipe using casing insulators made of durable and electrically non-conductive materials. Casing end seals shall be installed to prevent ingress of water and / or foreign material into casing. Vent and drains shall be provided on near ends of the casing pipe. If required, the carrier pipes outside the casing pipe shall be independently supported.

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

Installation of carrier pipe at road / highway crossings without casing shall be checked for allowable stresses in accordance with API RP-1102.

10.6.2 WATER CROSSINGS:

Crossings should be located in a comparatively straight reach of the water body, where the banks are stable, minimum evidence of erosion of bed, sufficient area for construction is available. For major canal / river courses angle of crossing shall be as close to 90° as possible.
For canals/drainage/ditch / nala /stream and other water courses, the angle of crossing shall be in no case less than 60° to the centre-line of the canal/drainage ditch.

Special considerations shall be required for submerged 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 water mark to high water mark) both during the design and installation of such crossings. For river crossings the following additional requirements shall be considered.

(a) River crossings installed by open-cut bottom pull method may necessitate additional weight coating to hold the pipeline in place during installation and operation.

(b) Pipeline profile of crossings installed by other techniques such as Horizontal Directional Drilling (HDD) or Micro Tunnelling should be selected carefully to ensure stability of hole and ease of pulling / pushing of pipe during installation.

(c) Stress analysis should be carried out taking into consideration the effect of all loads during installation to ensure pipe stresses during installation, testing and operation are well within permissible limits set by ASME B 31.8. Higher thickness, if required, to limit the stresses shall be used.

10.7 Pump Station, Terminal Station IP station and SV stations:

Typical scheme of a pumping station, Terminal station, IP station and SV stations (Remote / Manual) are enclosed at Annexure-III, IV, V, VI and VII respectively.

11.0 TESTING AND COMMISSIONING:

11.1 Pressure Testing of pipeline:

a) Rail/ Road / River crossing sections shall be hydro tested before and after installation at least for 4 hours at 1.25 times the design pressure.

b) All sections including previously hydrostatically tested one viz., road / rail and river crossings shall be retested along with completed mainline sections.

c) A gauging pig shall be passed through the pipeline to prove the internal diameter of the entire pipeline. The gauging plate shall have minimum diameter of 95% of the thickest line pipe used in internal diameter of the pipeline.

The gauging plate should preferably be made of minimum 10 mm thick Aluminium plate and shall have incisions at every 45 degrees.
d) All electrical connection and monitoring points on the pipelines shall be completed before pressure testing.

No welding (other than tie-in welds) and/or mechanical handling of pipe is permitted after pressure testing. Pipe used for making repairs after a leak shall be pre-tested to the same test pressure as the originally installed pipe.

e) Water used for the test medium shall be inhibited water i.e., water to which suitable doses of corrosion inhibitors are added depending upon quality of the water.

f) API-1110 shall be used for guidance for the hydrostatic test.

g) The minimum test pressure at any point along the pipeline shall be 1.25 times the internal design pressure of the thinnest pipe in the test section.

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.

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 bar. Pipelines not meeting the requirements shall be repaired and retested in accordance with the requirements of this standard.

Mainline valves should be installed after successful pressure testing of the pipeline.

h) Internal test pressure of high pressure station piping shall be done for a duration of not less than 4 hrs in line with ASME B31.4.

i) 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.

11.2 GEOMETRIC SURVEY:

The Calliper Survey shall be conducted after completion and acceptance of all the following mainline activities:

(i) Gauge plate run
(ii) Hydrostatic Testing
(iii) Cleaning and swabbing of pipeline
(iv) Mainline Valve installation

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(v) Test section tie-ins
(vi) After tie-in of HDD crossings / other submerged crossings.
(vii) Installation of launching and receiving barrels

11.3 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 or gas at a pressure of 7.0 kg/cm² and checked by means of soap solution / suitable digital gauge for leaks.

11.4 PRESERVATION OF PIPELINE:

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 inhibited dosed with adequate quantity of corrosion inhibitors or by filling the line with non-flammable nontoxic gas and at a positive pressure.

11.5 DOCUMENTATION:

Following records shall be made and maintained:

a. A complete pipe book including
b. Pressure test records including location of leaks or failures, if any, and description of repair under taken.
c. 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.,
d. Equipment manuals supplied by manufacturers.
e. Complete asset of each location with identification.
f. NDT records of welds
g. Geometric survey reports and repairs, if any, carried out.

11.6 COMMISSIONING:

11.6.1 A proper commissioning procedure shall be prepared for removal of air from the system and to prevent intermixing of air and the hydrocarbons. Intermixing of hydrocarbons could be avoided by putting required no. of Nitrogen or water column in between air and hydrocarbons.

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11.6.2 Before starting commissioning activities followings are to be ensured.

(i) Pressure testing is completed for entire pipeline and associated station piping.
(ii) Pipeline has been cleaned and ferrous material / debris etc. removed.
(iii) All mainline / sectionalizing valves are installed as per requirement.
(iv) Geometric survey of pipeline, section is carried out, when specified.
(v) Firefighting facilities are ready.
(vi) Trained and experience personnel are available/deployed to carry out commissioning
(vii) All caution boards displayed
(viii) Coating survey has been carried out either by Pearson, Direct current voltage Gradient (DCVG), Close Interval Potential Logging Survey (CIPS) or Current Attenuation Test (CAT).
(ix) Low pressure leak check (with air) of the above ground piping / flanged joints completed.
(x) Pre-commissioning safety audit by OISD completed and compliance submitted.

11.6.3 WATER / NITROGEN FILLING:

i. All gaskets shall be changed after hydro test.

ii. At the time of filling water / nitrogen, air shall be released from vent points.

iii. At this stage the system shall be checked thoroughly for leak proof test.

iv. The complete leak testing at installation during commissioning at 10% above the working pressure but not exceeding design pressure of the vessel shall be proof test over and above the hydro test undertaken for various equipment & facilities at earlier stage. This will ensure leak proof ness of the system as a whole before charging the system with LPG.

v. Gasket shall be checked & replaced in case any flange joint is found leaking during leak testing.

11.6.4 LPG CHARGING:

i. Liquid LPG shall not be directly used for displacement of air in pipeline / vessels.

ii. LPG shall be charged only after ensuring elimination of / absence of oxygen.

iii. While charging LPG, water / Nitrogen shall be drained simultaneously maintaining a positive pressure of around 1-2 kg/ cm² in the pipeline.

iv. Pressure in the pipeline system shall be monitored and creation of vacuum condition to be prevented.

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v. Where water draining is resorted to, by opening of end flanges of headers / pipelines, such flanges shall be blinded at the end of draining operation.

vi. In case of displacement of Nitrogen with LPG, constant reading of LPG – air mixture should be taken with explosive meter to ascertain the displacement of Nitrogen with LPG.

vii. Provision should be made for proper drainage of water from vessel, pipelines and equipment. In case of Nitrogen displacement, controlled venting shall be done.

viii. LPG shall be introduced at a controlled rate after displacement of entire water / Nitrogen.

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

12.0 INTERFACE BETWEEN PIPELINE OPERATOR & CONSUMER TERMINAL

12.1 INTERFACE PIPING:

The primary safety requirement of the interface piping system is to ensure that in the abnormal operating conditions / emergencies, either supplier or the consumer / receiver is not subjected to pressure more than the allowable operating pressure of the system.

12.2 ROV (Remote Operation Valve):

a) ROV shall be provided in supplier’s terminal and consumer’s premises, which will shut off the supply of LPG in case the pressure goes beyond piping design pressure of consumer terminal.

b) There shall be a time lag between closure of ROVs at consumer end and at the supplier’s end. The time lag shall be engineered properly so that pressure does not increase beyond the specified limit in the consumer terminal.

c) While engineering the closure time of ROV, a consideration shall be given so that the pressure due to surge does not exceed the design pressure.

d) A suitable continuous back-up power supply shall be provided for the control system and operation of ROVs both at suppliers end and consumers end.

12.3 SURGE ANALYSIS:

A detailed surge analysis shall be carried out during design stage considering the sudden closure / stoppage of the following:

(i) ROV of the storage vessel valve

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(ii) Any ROV in the delivery pipeline.

(iii) Pump at Intermediate pump station.

(iv) Any other condition which can generate surge pressure.

Based on the outcome of the surge analysis, surge protection measure to be taken.

12.4 CONTROL SYSTEM AND INSTRUMENTATION:

i. Critical control parameters i.e., storage vessel level, pressure, temperature, flow, quantity, ROV and MOV status shall be shared / made available & monitored in the control rooms of Supplier’s and Consumer’s company.

ii. Control system logic shall be designed in such a way that any variation from the pre-set design limit shall put the system in the fail safe operating condition.

iii. In case of emergency the pipeline ROV shall close earlier than Storage vessel ROV. An interlock / circuitry shall be incorporated in the design.

iv. Any bypassing of interlocks in the receiving terminal shall be informed to the receiving organization. Adequate precautions shall be spelt out clearly and adhered to whenever any interlock is bypassed as per OISD-GDN-178.

12.5 ANNUNCIATION:

The following indications shall be incorporated in the control rooms of both supplier and consumer company.

(a) Close indication of LPG storage ROV.

(b) Pr. Switch High High of LPG storage.

(c) Level Switch High High of LPG storage.

(d) Pr. Switch High High of LPG receiving pipeline system.

(e) Pr. Switch High High of main LPG pipeline.

(f) Any fire/emergency in supplier / receiver installation.

12.6 The typical arrangement of piping at custody transfer point and its protection is as per enclosed sketch at Annexure-VIII.
12.7 OPERATION & MAINTENANCE PROCEDURES:

A detailed operation and maintenance procedure for control system and safety interlocks shall be developed mutually. Roles and responsibilities along with action to be taken in case of emergencies shall be incorporated in the procedures of each company. Change in procedures shall be in line with OISD-GDN-178.

13.0 SAFETY & FIRE PROTECTION SYSTEM:

13.1 FIRE FIGHTING FACILITIES: PUMPING / INTERMEDIATE STATIONS:

13.1.1 DESIGN BASIS:

(i) The single largest risk shall be considered.

(ii) The basis of design of fire protection facilities should presume that no external fire-fighting agencies would be available for main pump station, intermediate pump station and pipeline terminal station for a duration of minimum 4 hours.

(iii) All LPG pumps (booster and mainline pumps), Pig launcher and receivers, metering area, filtering area and receipt & delivery manifold area shall be fully covered by medium velocity spray system.

(iv) Heat detectors through thermal fuses / quartz bulbs (QB to blow at 79° C) / Electro pneumatic (EP) detectors for detection of fire for automatic actuation of medium velocity water sprinkler system shall be provided. The QB / EP detectors shall be placed directly overhead or inside the hazard. In areas without specific hazard, detectors shall be placed evenly across the ceiling or with a maximum spacing of 3 meter inside the shed. Any other detectors if provided shall comply with the design requirement.

13.1.2 FIRE WATER SYSTEM:

The fire water system shall consist of:

(a) Fire water Pumps (Main and Jockey)

(b) Fire water storage

(c) Fire hydrant / Monitor distribution piping network

(d) Water sprinkler / Deluge system

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13.1.3 DESIGN FLOW RATE:

The fire water pumping requirement for medium velocity spray system shall be calculated based on following cooling rate:

(i) **Pump Shed:**

Medium velocity sprinkler system having remote and local operated deluge valve with spray density 20.4 LPM / Sq.M. area of the pump shed to be calculated considering outer foundation column distances.

(ii) **Scraper area, Metering area/ Filtering area and receipt / delivery manifold area:**

Medium velocity sprinkler system with spray density 10.2 LPM/ Sq.M of surface area to be considered.

Pump house shall be considered as single risk area. Alternatively, it can be divided into suitable number of zones with minimum 10 meter width.

The fire water system in the plant shall be designed to meet the highest fire water flow requirement of a single largest area risk at a time plus 288 M³ / Hr for operating 2 Nos. of fire water monitors / supplementary hose requirements.

13.1.4 FIRE WATER SYSTEM DESIGN:

(i) The fire water pressure system shall be designed for a minimum residual pressure of 7.0 Kg/ Cm².

(ii) A fire water ring main shall be provided all around perimeter of the plant facilities with hydrants / monitors spaced at intervals not exceeding 30 mtr. Fire hydrants monitors shall not be installed within 15 mtr from the facilities / equipment to be protected.

(iii) Fire hydrant network shall be in closed loops to ensure multidirectional flow in the system. Isolation valve shall be located near loop junction. Additional Isolation valves shall be provided where the length of the pipe section is more than 300 mtr.

13.1.5 FIRE WATER STORAGE:

(i) Water requirement for Firefighting shall be met above ground tanks of steel or concrete or masonry. The effective capacity of the tanks above the level of suction point shall be minimum 4 hrs aggregate capacity of the pumps. Where make up water supply system is 50% or more this storage capacity may be reduced to 3 hrs
of aggregate capacity of pumps.

(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.

13.1.6 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) shall be installed to maintained the fire network pressure at 7.0 Kg/ Cm² at farthest end of the network.

(iii) The fire water pumps including the stand by pumps shall be diesel driven. Where electric supply is reliable 50% of the pumps may be motor driven. Pump shall be capable of discharging 150% of its rated discharge at a minimum of 65% of rated head. Each engine shall have an independent fuel tank of suitable size for 6 hrs continuous running.

(iv) A minimum of 50% stand by pump(s) (minimum one no) of the same type and capacity as the main pumps shall be provided.

(v) The fire water pumps shall be provided with automatic starting facilities.

13.1.7 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. In case of sea water service, the fire water main pipes shall be concrete / mortar lined internally.

(ii) Fire water ring main shall be laid above ground at a height of 300 mm to 400 mm above finished ground level.

(iii) The mains shall be supported at regular intervals not exceeding 6 mtrs. For pipeline size less than 150 mm diameter, support interval shall not be more than 3 M.

(iv) The ring main may 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) The main shall have 1 mtr earth cushion in open ground and 1.5 mtr cushion under
the roads.

(vi) The underground fire water 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 shall be provided at each hydrant points.

(x) The deluge valve shall be located at 15 mtrs. from the risk being protected. A fire wall shall be provided for the protection of the deluge valve and for operating personnel.

(xi) Fire Hydrants/ monitors shall be located at a minimum distance of 15 mtrs from the hazardous facility / equipment. In 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.

(xii) 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 interval.

13.1.8 MEDIUM VELOCITY SPRINKLER SYSTEM:

The medium velocity spray system provided at all critical areas shall have spray nozzles directed radially to the facilities intended for cooling at a distance of 0.6 mtr from the surface of the equipment / facility. Only one type and size of spray nozzle shall be used in a particular facility.

13.1.9 All spray nozzles shall be inspected for proper positioning, corrosion and cleaned if necessary at intervals not more than 12 months or earlier based on actual experience. Care shall be taken in positioning nozzles so that water spray does not miss the targeted surface and reduce the efficiency or calculated discharge rate.

13.2 GAS MONITORING SYSTEM:

(i) The Gas Monitoring system shall be provided for early warning on build-up of dispersed gas concentration below LFL (lower flammable level) limits. These detectors for the gas monitoring system shall be located close to the potential source of leakage.
(ii) The control equipment shall be able to generate at least two alarms at different level of LEL concentration.

(iii) The detectors shall be located at least 0.3 meter away from potential source of leakage at height not more than 0.3 meter from the mounting level.

(iv) Detectors shall be placed in the pump shed and near scraper / filter, cold vent and cold flare area.

(v) The inspection of the system shall be done at an interval of 1 month in which the gas shall be released at all the detectors and performance of the system shall be established. Detectors shall be calibrated every three months with known and certified level of concentration.

(vi) Each station should have minimum 2 Nos. of spare detectors to facilitate immediate replacement.

13.3 FIRE ALARM SYSTEM:

(i) Manual call points shall be provided at strategic operating locations.
(ii) Electric operated fire sirens audible 1 KM from the periphery of the plant shall be installed.
(iii) Manual operated fire sirens shall be provided at strategic places.
(iv) Smoke detectors shall be provided in control room, MCC, utility room with provision of indication, alarm & annunciation.

13.4 MATERIAL SPECIFICATIONS:

All materials used in fire water system using fresh water shall be of the type indicated below:

a) 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.

b) 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.

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c) Hydrant Stand post, Monitors – Carbon Steel / Gunmetal.

d) Outlet valves/ landing valves- Gunmetal / Aluminium/ Stainless steel / Aluminium-Zinc alloy.

e) Fire Hose- Reinforced rubber lined hoses (63 mm), 15 mtr standard length conforming to IS: 636 (type A) / Non percolating synthetic hose (Type B) / UL or equivalent standard.

f) The above ground fire water main, hydrant post shall be painted with corrosion resistant “fire Red” paint as per IS: 5.

g) Water monitors, hydrant point and hose box shall be painted “ Luminous Yellow” as per IS: 5

13.5 FIRST AID & FIRE FIGHTING EXTINGUISHERS :

The fire extinguishers shall be provided at various locations as under:

(i) LPG Pump Houses - 1 x 10 Kg DCP / 50 m²

(ii) Office/ Canteen/Stores- 2 x 10 Kg DCP in each building.

(iii) MCC/DG Room/HT room- 2 x 4.5 Kg CO₂ in each room or per 100 m² floor area. 4 sand buckets & stand shall be provided in DG room.

(iv) 100% spare for CO₂ cartridges and 50% DCP cartridges shall be stored.

(v) One No. Mobile 75 Kg DCP fire extinguisher shall be provided in LPG pump house.

(vi) A trolley containing first aid fire protective accessories shall also be provided.

13.6 HOSES, NOZZLES AND ACCESSORIES :

(i) Minimum 2 Nos. or 25% spare hoses shall be stored.

(ii) In addition to the nozzles provided in the hose boxes there shall be one set of spare nozzles for each category viz., Jet Nozzle with branch pipes, Fog Nozzle, Universal Nozzle, water curtain Nozzle and spray nozzle.

(iii) The following accessories / first aid items shall be provided in each pump, intermediate and pipeline terminal station :

(a) Fire hoses – 2 nos. / per hose box / per hydrant point.
(b) Safety helmets-1 no./person (min 10 nos.).
(c) Stretcher with blanket- 2 Nos.

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(d) First aid box - 2 nos.
(e) Rubber hand gloves for electrical purpose - 2 nos.
(f) Low temperature rubber hand gloves - 4 pairs.
(g) Low temperature protective clothing - 2 sets.
(h) Fire proximity suit - 1 no.
(i) Resuscitator - 2 Nos.
(j) Red / green flags – 1 set.
(k) Self-contained breathing apparatus with one spare cylinder (cap 30 min) – 1 no.
(l) Water jel blanket- 2 nos.
(m)Portable Gas detectors/ Explosive meter – 2 Nos.

Inspection of fire fighting equipment and system shall be carried out in line with OISD-STD-142.

13.7 Emergency shutdown (ESD) push-button system:

Emergency shutdown push-button system shall be provided at vantage points in the operating area. In case of emergency in supplier’s company ESD shall actuate the following:

- Remote Operated Valve (ROV) on the custody transfer line to the consumer will close.
- Shut down all other facilities as incorporated in the designed.

Additionally, push buttons for initiating all the above actions shall be provided on remote operating panel and also in field at safe location for enabling manual actuation of a trip by operator. In the field, manual bypass valves of fire water deluge valves shall also be provided. Arrangement to routinely test the security system shall also be provided.

13.8 Windsock:

Windsock shall be provided on an appropriately elevated structure like the control room / fire-water pump house in such a manner so as to avoid blind areas.

13.9 Emergency power supply:

Emergency lighting shall be provided for the operating areas & control room in line with OISD-StTD-149 & OISD-STD-173 provisions.

13.10 Communication system:

(i) Communication system like telephone / PA or paging, walkie-talkie, optical fibre cable based communication system shall be provided.
(ii) In hazardous area, flame-proof / intrinsically safe telephones shall be provided.

(iii) Wherever possible Hot line connection between city fire Brigade / nearby major industries shall be provided.

(iv) Effective communication system shall be provided between supplier and consumer company.

(v) All intermediate stations including SV stations shall be linked with a reliable and proven communication system. Security at unmanned valve stations shall be trained to deal with communication in normal & emergency situations.

13.11 MARKERS:

13.11.1 Pipeline markers shall be provided on each side of road, railway crossing, water crossings and at a maximum spacing of 1 km along the right of way of the remainder of the buried pipeline along the right of way.

13.11.2 At the entrance to all pipeline stations, caution signs to be displayed indicating hazardous area, name of the operating company emergency telephone contact nos. etc.,

14.0 EMERGENCY PREPAREDNESS:

14.1 Emergency Plan:

The emergency plan is to be based on maximum credible risk scenarios as specified in the OISD-STD—168 on “Emergency preparedness plan for marketing location of oil industry”. It shall cover the following:

(i) Geographical area covered, the number and sizes of the pipeline systems involved, and the normal operating conditions, including pressure and rate flow.

(iii) Written instructions and procedures to be adhered to in case of an emergency. Understanding of the same by the operational staff.

(iv) Instrumentation, control equipment and communication to enable the controller to direct all operations related to emergency.

(v) Warning on delay of abnormal operating conditions.

(vi) Roles of all organizations involved & periodic meetings to be conducted to ensure integration in terms of resource mobilisation, response & resolving issues having mutual responsibility during emergency.

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14.2 Basis of Emergency Plan:

The emergency plan shall be prepared based on the following and shall be approved by respective factory inspector and district authorities under their jurisdiction.

a) Risk Analysis & HAZOP Study:

Detailed HAZOP & operability study to be conducted involving design, operation & maintenance group to identify the likely deviations in the operating parameters from the designed level & corrective measures incorporated.

Risk analysis & HAZOP study to be reviewed & updated at regular intervals.

Such studies shall be carried out for the pipeline section under each station & merged with the overall plan.

b) Risk scenarios:

Release of LPG leading to spillage, vapour cloud formation, fire & explosion shall be considered for various scenarios along with their method of containing.

c) Flow balance record:

A regular flow balance record shall be maintained preferably automatically, to assist detection of leakage.

d) Organization structure:

Emergency organization structure shall be drawn encompassing individual section i.e. pumping, pipeline & receipt & dovetailed to form an integrated organization structure having chain of command, communication & control system so that action can be initiated as fast as possible.

e) Responsibility:

Responsibility of all concerned to be clearly defined, particularly where there is an interface between the supply & the receiving company. The transferring & the receiving organizations shall make mutual agreements for this purpose. Such plans shall be updated on yearly basis to manage the change in rules, equipment, process, technology, procedures, manpower etc.

14.3 Emergency Control Centres:

(i) Designated emergency control centres shall be constituted at the main terminal, booster stations & receiving terminals with round the clock communication link
among them. Emergency organisation structure with actions to be taken in case of an emergency, shall be displayed in the control centres and documented. Each SV station shall be attached with nearest emergency control centres. Emergency contact nos. with action in case of emergency shall be displayed in SV stations and along the pipeline route.

(ii) Emergency control centres will be established at the following stations:
   a. Main pipeline terminal
   b. Pump stations
   c. LPG Receipt Terminal

(iii) Names of contact personnel will be declared for following stations.
   a) Main pumping station
   b) Booster station
   c) SV station
   d) Receipt terminal

(iv) List of fire stations with contact persons, telephone nos. along the pipeline route shall be prepared and maintained at each station. Information with regard to the system & emergencies to be handled to be shared with the local fire stations & coordination to be maintained on regular basis for this purpose.

(v) Written mutual aid plan shall be drawn between the supplier & consumer organizations & reviewed periodically.

(vi) Periodic meetings, at least once in a quarter shall be organized between the supply & receiving organizations to deliberate & resolve the issues related to safety, operation & emergency systems & corrective measures shall be instituted.

14.4 Emergency Training:

i. All operational staff should be properly trained to handle normal and emergency situations.
ii. Induction, detailed & refresher training shall be imparted to the operating, maintenance, security staff in handling of emergency situations.
iii. Emergency booklets shall be prepared covering emergency action at each work station & issued to all concerned personnel.

14.5 EMERGENCY MOCK DRILL:

Regular mock drill shall be conducted as per approved emergency plan at all the above stations. Deficiencies identified & corrective action taken shall be documented.
In addition to independent mock drills by the supplier & the consumer organization, combined drills shall be organized once in six months to test the efficacy of response in emergency situations. Performance & findings of combined emergency drills shall be shared & documented between the organizations to sustain emergency preparedness at the highest level.

Offsite mock drill at least once in a year to be conducted involving district authorities and local statutory bodies and observation, deficiencies and records to be maintained.

15.0 PIPELINE OPERATION AND MAINTENANCE:

15.1 Operating Procedures:

A comprehensive operating manual shall be developed which shall include following:

i. System Description
ii. Operation set points
iii. Initial start up
iv. Normal operations
v. Normal shut down procedure
vi. Temporary operations
vii. Execution of emergency shutdown in a safe & timely manner
viii. Emergency shut down
ix. Conditions under which emergency shutdown is required
x. Emergency operations

15.2 DISPLAY OF OPERATING INSTRUCTIONS:

The gist of operating instructions, emergency shutdown (ESD), Trip set pressures shall be displayed in the control room and near all important operating equipment

15.3 MAINTENANCE PROCEDURE:

A detailed maintenance procedure shall be developed for entire pipeline system considering the recommendation given by original equipment manufacturer bearing in mind the local conditions. To facilitate the maintenance services to be rendered in a planned manner, a preventive maintenance schedule covering necessary work to be done, mentioning the periodicity i.e. daily, weekly, monthly, half yearly and yearly schedule shall be worked out and adhered to.

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15.3.1 Pipeline Repair:

(a) Repairs shall be covered by a maintenance plan and shall be performed under qualified and trained personnel familiar with hazards to public safety, utilization of proper equipment and repair material. This shall be done in line with AMSE B 31.4, API Publication 2200, API 1104 and API RP 1111. Approvals, procedures and special consideration as per API Publication 2201 shall be observed for welding as well as hot tapping on pipeline, vessels or tanks which are under pressure. Piping in the vicinity of repair shall be adequately supported during and after the repair.

(b) If an inert fluid is used to temporarily displace the liquid in the pipeline system for the purpose of repair, a detailed procedure containing the following shall be prepared.

(i) Maximum flow rate.
(ii) Pressure
(iii) Injection temperature
(iv) Disposal of the liquid.
(v) Safety procedure

(c) Dents meeting any of the following condition shall be removed or repaired.

(i) Dents which affect the pipe curvature.
(ii) Dents containing a scratch, gouge or groove.
(iii) Dents exceeding a depth of 6 mm in NPS 4” and smaller or 6% of nominal pipe diameter in sizes greater than NPS 4.
(iv) Dents containing external corrosion where remaining wall thickness is less than 87.5% of that of required for design.

(d) All pipes containing leak shall be removed or repaired.

(e) Pipeline shall be repaired by any one of the following:

(i) 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.
(ii) By installing full encirclement welded split sleeves to contain internal pressure and shall have a design pressure of not less than the pipe being repaired. This shall be fully welded both circumferentially and longitudinally. Length of full encirclement split sleeves shall not be less than 100 mm.

(f) 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.

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15.3.2 Right of Way Maintenance:

(a) There shall be proper maintenance of Right of Way to have clear visibility and to give reasonable access to maintenance crews.

(b) Valve location access shall be properly maintained.

(c) To protect against washouts on the line and erosion of the landowner’s property, diversion, ditches or dykes shall be maintained wherever required.

15.3.3 Patrolling:

(a) A periodic pipeline patrolling program should be maintained for the R.O.W by the operating company to observe surface conditions, leakage, construction activity, encroachments, soil washouts and any other factors affecting the safety and operation of the pipeline.

(b) Periodic inspection shall be carried out for underwater crossings for sufficiency of cover, accumulation of debris, or for any other condition affecting the safety and security of the crossings.

(c) Patrolling of On-shore LPG Cross Country Pipelines shall be carried out once in a week.

(d) Line Walk by the official of the company at least once in a year is required to be conducted after the monsoon.

(e) The operating company shall analyse the existing pipeline for new anticipated external loads, when the pipeline is to be crossed by a new road or railroad. The operating company shall install mechanical reinforcement, structural protection, or suitable pipe, in case the design parameters considered are exceeding in order to ensure redistribution of the external loads acting on the pipeline.

15.4 PIGGING:

(i) Scraper pigging is required to be done at least once a year.
(ii) Intelligent pigging survey shall be carried out once in 10 yrs.
(iii) Muck/ contaminants should be chemically analysed and safely disposed as per relevant statutory guidelines.

15.5 INSPECTION OF CATHODIC PROTECTION SYSTEM:

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

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

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.

15.5.2 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.

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

15.5.4 Cathodic protection rectifiers shall be inspected once in three months.

15.5.5 All protective devices shall be inspected once in three months.

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15.5.6 Interference bonds shall be inspected once a year.

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

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

15.6 COATING SURVEY:

15.6.1 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.

15.6.2 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.

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

15.7 Insulating joints and couplings shall be inspected once in a year.

15.8 BACK UP POWER FOR CP SYSTEM:

Where ever 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.

15.9 INSPECTION OF PIPE, VALVES AND FITTINGS:

(a) Whenever any pipe or component in a piping system can be visually examined internally or pipe or components are removed from a piping system for any reason, the internal surfaces shall be inspected for evidence of corrosion and if corrosion is found, the adjacent pipe or component shall be examined. Discovery of active corrosion, general pitting of the pipe or component surface, or a leak caused by corrosion shall be investigated further to determine the cause and extent of the corrosion and further steps shall be taken or augmented to mitigate corrosion.

(b) Inspection of pipes, valves and fittings shall be carried out as per OISD-STD 130.

15.10 Control and Protective Equipment Periodic inspections and maintenance shall be carried out for controls and protective equipment, including pressure limiting devices,

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regulators, controllers, relief valves, and other safety devices in accordance with OEM and following OISD Standards:

Pumps : OISD –STD-119  
Compressors : OISD – STD-120  
Pressure Limiting Devices: OISD –STD-132

15.11 DOCUMENTATION:

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

(a) All records as per clause 11.4 of this document.
(b) Necessary operation data
(c) Pipeline patrolling records
(d) Records and maps showing the location of CP facilities and piping.
(e) CP monitoring report, test and survey reports.
(f) Leak and burst records
(g) Records pertaining to routine or unusual inspections, such as external or internal line conditions
(h) Pipeline repair records
(i) History cards of equipment.
(j) Near miss, minor and major incidents.

16.0 PIPELINE INTEGRITY MANAGEMENT (PIM):

16.1 A comprehensive manual containing program & 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.

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

16.3 The integrity management program shall have following basic elements taking into consideration specificity & merit involved case to case basis:

(a) Classification of consequence zones/mapping of the pipeline & updated documentation,

(b) Analysis that integrates all available information on the pipeline operation, inspection, surveillance, patrolling, incidents and the consequences of a failure, criteria for remedial measures,

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(c) A continual process of assessment & documentation and evaluation to maintain a pipeline integrity,

(d) Identification of preventive & protective measures to protect high consequence areas.

(e) Methods to determine program’s effectiveness,

(f) Process of review of results by a person qualified to evaluate the results.

16.4 Prompt action shall be taken to address all anomalous conditions that is discovered through the integrity assessment or information analysis, surveillance /patrolling etc.

16.5 To maintain safe operating conditions in case of an adverse conditions detected, pipeline should be shut down until the required repairs are completed and clearance for operation is given.

16.6 In addressing all conditions, health & integrity status, all anomalous conditions of operations which could reduce the integrity of the pipeline should be evaluated and remedial action to be taken.

16.7 The methods selected to assess the integrity of the pipeline initially shall be one and / or combination of the following:

(a) Internal inspection tool or tools capable of detecting corrosion and deformation anomalies including dents, gouges, grooves e.g., Geometric Survey.

(b) Hydrostatic Pressure test conducted in accordance with clause 11.1 of this document.

16.8 The integrity assessment schedule shall be based on all risk factors that reflect the risk conditions on the pipeline segment.

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

16.10 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

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

*****
17.0 REFERENCES:

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

i. ASME B.31.4 – Pipeline Transportation System for Liquid Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols.

ii. ASME B.31.3 - Process Piping for petroleum refineries, chemical, pharmaceutical, textile, paper, semiconductor, cryogenic plants and related processing plants and terminals.

iii. API – 2510 – Design and Construction of LPG Installation

iv. API 1102 - Recommended Practice for Liquid Petroleum Pipelines Crossing Railroads and Highways.

v. API 1104 - Standard for Welding Pipelines and Related Facilities.

vi. API 1107 - Recommended Pipeline Maintenance Welding Practices.

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

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

ix. API 2200 - Repairs to Crude Oil, Liquefied Petroleum Gas and Products Pipelines.

x. API 2201 - Procedure for Welding or Hot Tapping on Equipment Containing Flammables.

xi. API 2209 - Pipeline Plugging Practices.

xii. API 500C - Classification of Locations For Electrical Installations at Pipeline Transportation Facilities.

xiii. ASME - Boiler and Pressure Vessel Code, Section VIII Division 1 Pressure Vessels, Section VIII Division 2 Alternate Rules for Pressure Vessels, and Section IX – Welding Qualifications

xiv. MSS-SP-50 - Pipe Hangers and Supports Materials, Design and Manufacture.

xv. MSS-SP-69 - Pipe Hangers and Supports - Selection and Application.

xvi. NACE-RP-01-69 - Recommended Practice Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

xvii. NACE-RP-01-75 - Recommended Practice - Control of Internal Corrosion in Steel Pipelines Systems.

xviii. OISD –STD-118 - Lay out of Oil and Gas Installation

xix. OISD –STD-119 - Inspection of Pumps

xx. OISD –STD-120 - Inspection of Compressors

xxi. OISD –STD-128 - Inspection of Pressure Vessels.

xxii. OISD –STD-130 - Inspection of Pipes, Valves and Fittings.


xxv. OISD –STD-141 - Design and Construction requirements for cross country hydrocarbon pipelines.


xxviii. OISD –RP-149 - Design aspect for safety in Electrical system


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## SPECIFICATION OF LIQUIFIED PETROLEUM GASES (LPG)
### IS: 4576: 1999

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Characteristics</th>
<th>Requirement for LPG</th>
<th>Method of Test Ref to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vapour Pressure @ 40° C, Kpa, gauge max (See note 1)</td>
<td>1050</td>
<td>D : 1267</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(See Note 2)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Composition, liquid mole percentage</td>
<td></td>
<td>D : 2163</td>
</tr>
<tr>
<td>2a</td>
<td>C 2 Hydrocarbons</td>
<td>Report</td>
<td></td>
</tr>
<tr>
<td>2b</td>
<td>C 3 Hydrocarbons</td>
<td>Report</td>
<td></td>
</tr>
<tr>
<td>2c</td>
<td>C 4 Hydrocarbons</td>
<td>Report</td>
<td></td>
</tr>
<tr>
<td>2d</td>
<td>C 5 Hydrocarbons &amp; heavier</td>
<td>2.5 Max</td>
<td></td>
</tr>
<tr>
<td>2e</td>
<td>Unsaturated Hydrocarbons</td>
<td>Report</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>Volatility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evaporate temperature in ° C., for 95 percent by volume. @ 760 mm pressure, Max</td>
<td>2</td>
<td>D : 1837</td>
</tr>
<tr>
<td>3</td>
<td>Total Volatile Sulphur, ppm, Max</td>
<td>150</td>
<td>D : 2784</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D : 3246</td>
</tr>
<tr>
<td>4</td>
<td>Copper Strip Corrosion @ 38° C for 1 hr</td>
<td>Not worse than 1</td>
<td>D : 1838</td>
</tr>
<tr>
<td>5</td>
<td>Hydrogen Sulphide</td>
<td>pass</td>
<td>D : 2420</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(Note 3)</td>
</tr>
<tr>
<td>6</td>
<td>Free water content</td>
<td>None</td>
<td>Visual</td>
</tr>
</tbody>
</table>

ASTM test method shall be followed till ‘P’ of IS 1448 methods under revision are finalized.

### NOTES:

1. Vapour pressure may be determined at any other temperature and converted to 40° C by means of suitable vapour pressure- temperature graph. The same can also be determined by analysing the gas by means of gas chromatograph & then using the composition, the vapour pressure can be calculated @ 40° C from the standard value of vapour pressure at various temperatures.
2. Each consignment of commercial Butane – propane mixture shall be designed by its maximum vapour pressure in Kpa at 40° C. Further, if purchaser and the supplier agreed, the minimum vapour pressure of that mixture shall not be lower than 200 kpa gauge compared to the designated maximum vapour pressure and in any case the minimum for the mixture shall not lower than 520 Kpa at 40° C.
3. *Pass* test indicates Hydrogen sulphide not more than 5 ppm.
4. Subject to agreement between the purchaser and the supplier, odour requirements of LPG may be changed for certain applications where unodourised LPG is required.
5. Product shall contain minimum 20 ppm ethyl mercaptan at the first dispatching location to ensure the detection of odour. To detect the odour, the following procedure may be adopted: 5 ml Doctor Solution + 8ml Iso-octane+pinch of sulphur powder in 25 ml stoppered cylinder. Shake and add 2 ml LPG Aq). Shake slowly by releasing pressure. Odour is adequate if sulphur turns yellowish brown. P: 75 odour test method may also be acceptable as an alternate method.
SPECIFICATION OF LIQUEFIED PETROLEUM GASES (LPG) FOR AUTOMOTIVE PURPOSE
IS: 14861: 2000

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Characteristics</th>
<th>Requirement</th>
<th>Method of Test Ref to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vapour Pressure @ 40° C, Kpa, gauge max (See note 1)</td>
<td>Min : 520 (See Note 2) Max : 1050</td>
<td>ISO : 4256</td>
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<tr>
<td>2</td>
<td>C3 Hydrocarbons and heavier, mole percent, Max</td>
<td>2.0</td>
<td>ASTM D : 2163</td>
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<tr>
<td>3</td>
<td>Dienes (as 1 : 3 Butadiene) mole percent Max</td>
<td>0.5</td>
<td>ISO 7941</td>
</tr>
<tr>
<td>4</td>
<td>Total Volatile Sulphur, (After stanching) ppm, Max</td>
<td>150</td>
<td>ASTM D : 3246</td>
</tr>
<tr>
<td>5</td>
<td>Copper Strip Corrosion @ 40° C for 1 hr, Max</td>
<td>Class 1</td>
<td>ISO : 6251</td>
</tr>
<tr>
<td>6</td>
<td>Hydrogen Sulphide</td>
<td>Pass the test</td>
<td>ISO : 8819</td>
</tr>
<tr>
<td>7</td>
<td>Evaporation residue, mg/Kg, Max</td>
<td>100</td>
<td>ISO : 13757</td>
</tr>
<tr>
<td>8</td>
<td>Free water content</td>
<td>Nil</td>
<td>ASTM E 700 (Note 3)</td>
</tr>
<tr>
<td>9</td>
<td>Motor octane number (MON), Min</td>
<td>88</td>
<td>ISO 7941 + Annex A</td>
</tr>
<tr>
<td>10</td>
<td>Odour</td>
<td>Unpleasant and distinctive down to 20 percent lower explosive limit(LEL)</td>
<td>(Note 4 and 5)</td>
</tr>
</tbody>
</table>

NOTES:
1 Vapour pressure may be determined at any other temperature and converted to 40° C by means of suitable vapour pressure-temperature graph. The same can also be determined by analysing the gas by means of gas chromatograph & then using the composition, the vapour pressure can be calculated at 40° C from the standard value of vapour pressure at various temperatures.
2 In winter, the gauge vapour pressure requirement shall be minimum 700 kPa at 400 C. winter period shall be from 1st November to 15th February.
3 The water content shall be determined at the Refinery / first dispatching station.
4 Product shall contain minimum 20 ppm ethyl mercaptan at the first dispatching location to ensure the detection of leakage by odour.
5 To detect the odour, the following procedure may be adopted
   5 ml Doctor Solution + 8 ml Iso-octane + pinch of sulphur in 25 ml stoppered cylinder. Shake and add 2 ml LPG (Aq). Shake slowly by releasing pressure. Odour is adequate if sulphur turns yellowish brown.

IS 1448 [P: 75] odour test method is also acceptable as an alternate method.
ISO / ASTM test method shall be followed till ‘P’ series of IS 1448 methods are published.

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SCOP Outline

Legend:
- Boundary Limit outside this Standard
- Units within Scope of this standard.
- Cross country pipeline within Scope Of this standard
- Pipeline Not in Scope of this Standard.
- Custody Transfer Points

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### Minimum Interdistances 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>
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<tbody>
<tr>
<td>1</td>
<td>Booster Pump House</td>
<td></td>
<td>15 *</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>60</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Mainline Pumps House</td>
<td>15 *</td>
<td></td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>60</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>30</td>
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<tr>
<td>3</td>
<td>Scraper Launcher</td>
<td>15</td>
<td>15</td>
<td></td>
<td>x</td>
<td>16</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>Scraper Receiver</td>
<td>15</td>
<td>15</td>
<td>x</td>
<td></td>
<td>16</td>
<td>30</td>
<td>15</td>
<td>15</td>
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<tr>
<td>5</td>
<td>Control Room</td>
<td>16</td>
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<td></td>
<td></td>
<td>30</td>
<td>15</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fire Pump House / Fire water</td>
<td>60</td>
<td>60</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
<td></td>
<td>60</td>
<td>12</td>
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<td>7</td>
<td>Water Spray Deluge Valve</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
<td>15</td>
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</tr>
<tr>
<td>8</td>
<td>Cold Flare</td>
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<td>15</td>
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<td>30</td>
<td>60</td>
<td>15</td>
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<td>30</td>
</tr>
<tr>
<td>9</td>
<td>Compound wall</td>
<td>30</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>30</td>
<td>12</td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Elect Substation,</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
<td>15</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In case Booster pumps and Mainline pumps are located in two different pump shed

x- Any distance suitable for constructional and operation convenience.

1. All distances are in metres. All distances shall be measured between the nearest points on the perimeter of each facility.

2. For other station facilities not covered in the above shall be governed by OISD-STD-144 and OISD-STD-118.

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ANNEXURE-III

SCHEMATIC LAYOUT OF A PUMPING STATION

MOV- motor operated Valve
TSV- Thermal Safety Valve
PCV- Pr. Control Valve
SLB- Scraper Launcher Barrel
SRB- Scraper Receiver Barrel
PG- Pt. Gauge
PS- Pressure Switch
PT- Pressure Transmitter

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TYPICAL INTERMEDIATE PIGGING STATION -

From - To TEG To Terminal

FLOW TEE MOV MOV

FLOW TEE

RECEIVER

BALL VALVE GLOBE VALVE LPG FLOW DIRECTION

GATE VALVE

TEG-TERMO ELECTRIC GENERATOR

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ANNEXURE - VI

TYPICAL MANUAL SV STATION

Utility Connection – 2"

4" By pass Line

Utility Connection – 2"

MANIFEST FOR PG /TG

PG

TG

AV + HPU

PG

TG

MAINLINE

Legends:

Gate Valve

Ball Valve

Globe Valve

Schematic Line Diagram

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Annexure VII

TYPICAL REMOTE SVs
(with Mobile Flare Tapping)

Legends:
- Gate Valve  Main Line
- Ball Valve  φ 4” By Pass Line
- Globe Valve  φ 2” TEG Fuel Line
- φ 4” Flare Line  φ 4” Manifold for PT/TT

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Schematic Line Diagram

Annexure - VIII

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List of Specifications of Piping Materials used in liquid hydrocarbon Pipelines

<table>
<thead>
<tr>
<th>Steel Pipe</th>
<th>Description</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>Description</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>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B16.5</td>
<td>Steel pipe flanges and flanged fittings - Size up to 24” 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>Description</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>Integrally 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>Description</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</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Other Special Purpose Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B18.2.1 Square and Hex Bolts and Screws, Inch Series.</td>
</tr>
<tr>
<td>ASME B18.2.2 Square and Hex Nuts.</td>
</tr>
<tr>
<td><strong>Gaskets</strong></td>
</tr>
<tr>
<td>ASME B16.20 Metallic gaskets for pipe flanges: Ring joint, Spiral wound and Jacketed.</td>
</tr>
<tr>
<td><strong>High Pressure SS Tubing and Fittings</strong></td>
</tr>
<tr>
<td><strong>Pressure Safety Valve and Pressure measuring equipment</strong></td>
</tr>
<tr>
<td>API 526 Flanged Steel Pressure Relief Valves</td>
</tr>
<tr>
<td>BS EN 837-1 Pressure gauges - Part 1: Bourdon tube pressure gauges; dimensions, metrology, requirements and testing.</td>
</tr>
<tr>
<td>BS EN 837-2 Pressure Gauges - Part 2: Selection and Installation Recommendations for Pressure Gauges.</td>
</tr>
<tr>
<td>BS EN 837-3 Pressure gauges - Part 3: Diaphragm and capsule pressure gauges; dimensions, metrology, requirements and testing.</td>
</tr>
<tr>
<td><strong>Filters</strong> : ASME Section VIII Boiler and Pressure Vessel Code.</td>
</tr>
</tbody>
</table>
Annexure-X
(Clause- 7.4.7)

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.

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