



**OIL AND NATURAL GAS CORPORATION LIMITED**

**REVAMPING OF LPG RAIL GANTRY & REVAMPING /  
AUTOMATION OF ROAD GANTRY AT PRODUCT  
TERMINAL AT ONGC, HAZIRA PLANT**



**DESIGN BASIS**

DOCUMENT NO.

9 2 4 2 - M - G A N - G E N - D B S - 0 0 0 0 1





**ESSAR PROJECTS (INDIA) LIMITED**  
ENGINEERING & PROJECT MANAGEMENT

 <b>ONGC</b> <b>OIL AND NATURAL GAS CORPORATION LIMITED</b>	<b>REVAMPING OF LPG RAIL GANTRY &amp; REVAMPING / AUTOMATION OF ROAD GANTRY AT PRODUCT TERMINAL AT ONGC, HAZIRA PLANT</b>	 <b>ESSAR PROJECTS</b>
	<b>DESIGN BASIS</b> <b>9242-M-GAN-GEN-DBS-00001</b>	<b>ESSAR PROJECTS (INDIA) LIMITED</b> <b>ENGINEERING &amp; PROJECT MANAGEMENT</b>

DATE	DETAILS OF REVISION	REVISION NO.
02/07/2013	ISSUE FOR CLIENT REVIEW	P0
26/07/2013	ISSUE FOR CLIENT REVIEW	P1
05/08/2013	ISSUE FOR CLIENT REVIEW BASED ON DISCUSSION	P2
13/08/2013	ISSUE FOR CLIENT APPROVAL	R0



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<b>Alpesh Lad</b>	<b>Nitesh Jani</b>	<b>V Raghunathan</b>
<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>

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### 1.0 Purpose:

The purpose of this document is to detail all the basic information required to form the basis for preparation of Tender document for LSTK Contractor for Project Revamping of LPG Rail Gantry & revamping / Automation of Road Gantry at Product Terminal at Oil and Natural Gas Corporation Limited (ONGC), Hazira Plant.

### 2.0 Scope:

This document describes the Design Basis for the project “Revamping of LPG rail gantry & Revamping / Automation of Road Gantry at Product Terminal at ONGC, Hazira Plant”.

### 3.0 Responsibilities:

The data enclosed in this document is applicable to all disciplines of ESSAR PROJECTS (INDIA) LIMITED – ENGINEERING & PROJECT MANAGEMENT & any third party vendors / suppliers. In case of conflict between the document and other project specific standards / specifications, reference should be made to the EPIL Project Manager for resolution.



The order of precedence of documents shall be referred for this project is as follows:

- a) The Indian Government rules and regulations
- b) Local state regulations (Gujarat)
- c) ONGC company procedures,
- d) International codes and standards

### 4.0 Definitions:

Following acronyms have been used in this document:

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ONGC – Oil and Natural gas Corporation Limited

EPIL – Essar Projects (India) Limited – Engineering & Project Management

LPG – Liquefied Petroleum Gas

HSD – High Speed Diesel

SKO – Super Kerosene Oil

ATF – Aviation Turbine Fuel

ESDV – Emergency Shut Down Valve

DSV – Digital Stop Valve

## 5.0 Introduction:

Products (LPG, HSD, ATF, & SKO) are received from storage terminal through pipe line. Delivery of products is through Rail wagon and Road tank trucks. LPG is transported through Rail wagon and Road tank trucks. HSD/ATF/SKO is transported through Road Tank trucks.

Product dispatch facilities are as follows:

LPG dispatching comprises of Rail loading gantry with 80 No's of loading points & 2 no's of decanting points, Road loading gantry of 08 No's of loading bays & 1 no decanting bay and PLT (Pipe Line Transfer) dispatch to IOC bottling plant, BPCL bottling plant. Additionally LPG PLT dispatch is planned for HPCL bottling plant.



HSD dispatching comprises of 2 nos. of loading bays in road gantry.

SKO dispatching comprises of 3 nos. of loading bays in road gantry.

ATF dispatching comprises of 2 nos. of loading bays & 1 no. open bay for ATF in Road Gantry.

ONGC has proposed to revamp LPG Rail Gantry and Revamping / Automation of Road gantry at product terminal at Hazira plant.

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#### 5.1 ATF / SKO / HSD Truck Loading

There are total 8 nos. of Loading Bays & 1 no of decanting bay in for POL (ATF/SKO/HSD) road loading gantry. Out of 08 nos. of bays, 07 nos. of bays are in operation. Bay no. 1 & 2 (loading arm of bay no. 2 is dismantled at present) for ATF loading. Bay no 3 is stand by for future ATF loading purpose. Bay no. 4, 5 & 6 are for SKO Loading, and Bay no. 7 & 8 for HSD loading. ONGC has proposed to revamp/automate currently operating bays no 4, 5, 6, 7 & 8 along with installation of ATF/SKO/HSD unloading new sump & pump with motor assembly.

#### 5.2 LPG Road Loading

There are total 8 nos. of Loading Bay & 1 no. of decanting bay in LPG Road Gantry. All these 9 nos. bays are in operating condition. In each bay there is one loading arm and one vapor balance arm. ONGC proposes to revamp / automate of all 9 nos. of bays.



#### 5.3 LPG Rail Loading

In LPG rail gantry, there is one North Gantry and one South Gantry. There are total 80 nos. of loading point and 2 nos. of Decanting point for LPG. All these points are not in good condition. ONGC proposed to revamp all 80 nos. of loading points.

#### 5.4 Naptha Rail Loading

One no. additional sump is proposed with sump pump along with motor and associated instrumentation for Naptha decanting. The proposed sump will be interconnected with the existing sump.

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## 6.0 Units of Measurement:

The Metric system of units will be used for all documentation. In general the units to be used on this project are tabulated below. Use of units not listed is to be kept to a minimum and must get prior approval from EPIL Project Manager.



Description	Unit
<b>Space and Time</b>	
Length	M (Meter), mm (Millimeter)
Area	m <sup>2</sup> , mm <sup>2</sup>
Volume at Standard and Natural	m <sup>3</sup> , mm <sup>3</sup> , l (liter), ml
Time	s (Sec), m (min), h (Hour), d (Day)
Velocity	m/s, mm/s, km/hr
Acceleration	m/s <sup>2</sup>
Volume Flow	m <sup>3</sup> /s, m <sup>3</sup> /h, m <sup>3</sup> /d, KL @15 <sup>0</sup> C
Plane Angle	Degrees / minutes / seconds
Angular Velocity	rad/s, rad/m
<b>PERIODICITY</b>	
Frequency	Hz, KHz, MHz
Rotational frequency	Rpm, Rev/s
<b>MECHANICS</b>	
Mass	MT (tonne), Kg
Mass Flow	t/h, Kg/h, Kg/s, t/d
Volumetric Flow	m <sup>3</sup> /h, KL @15 <sup>0</sup> C
Normal Volumetric Gas Flow	Nm <sup>3</sup> /h (0°C and 1.33 kg/cm <sup>2</sup> a)
Standard Volumetric Gas Flow	Sm <sup>3</sup> /h (at 15°C)
Density	Kg/m <sup>3</sup>

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Liquid Absolute Density	Kg/m <sup>3</sup> (at 15°C)
Force	N, KN
Moment of Force	Nm
Loading super	KN/m <sup>2</sup>
Loading Linear	KN/m
Stress	KN/m <sup>2</sup> , N/m <sup>2</sup>
Pressure (Absolute)	Kg/cm <sup>2</sup> a
Pressure (Gauge)	Kg/cm <sup>2</sup> g
Pressure (vacuum)	mm Hg
Energy, Work	MJ, KJ
Power	W, KW
Dynamic Viscosity	cP (centipoises)
Kinematic Viscosity	cSt (centistokes)
Surface Tension	mN/m
Level	%
Vibration	µm
<b>HEAT</b>	
Absolute temperature	K
Customary Temperature	°C
Heat Quantity	Kcal
Heat Flow rate	Kcal/h
Density of heat flow rate	kcal /m <sup>2</sup> h
Thermal conductivity	kcal/m <sup>°</sup> Chr
Coefficient of heat transfer	kcal/hr m <sup>2</sup> °C
Specific heat capacity	kcal/kg K
Calorific value (mass basis)	kcal/kg
Specific energy, specific enthalpy, specific latent heat	Kcal/kg
Calorific value (volume basis)	kcal/m <sup>3</sup>
<b>ELECRICITY AND MAGNETISM</b>	

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Electric current	A, kA, mA
Electric potential and electromotive force	kV V mV $\mu$ V
Electric field strength	V/m
Current Density	A/mm <sup>2</sup> A/m <sup>2</sup>
Resistance, impedance, reactance	M $\Omega$ , k $\Omega$ , $\Omega$ , m $\Omega$ , $\mu\Omega$
Resistivity	$\Omega$ m, $\mu\Omega$ m
Active power	MW, kW, W
Reactive power	MVA <sub>r</sub> , kVA <sub>r</sub> , VA <sub>r</sub>
Apparent Power	MVA, kVA, VA
Electric energy	MWh, Wh, MJ, kJ, J
Analysis	%, ppm, ppb
Conductivity	$\mu$ S/cm
<b>ILLUMINATION</b>	
Luminous flux	lm
Illumination	Lx (lux)

## 7.0 Site Information:

1.0	Owner / Purchaser	Oil and Natural Gas Corporation Limited
2.0	Consultant	Essar Projects (India) Limited – Engineering & Project Management
3.0	Project Title	Revamping of LPG Rail Gantry & revamping / Automation of Road Gantry at Product Terminal at ONGC, Hazira Plant
4.0	Location of Plant	Oil and Natural Gas Corporation Limited Hazira Gas Processing Complex ONGC Nagar (P.O.), Surat – 394 518 Gujarat, India
5.0	Nearest Railway Station	Surat
6.0	Nearest Domestic	Surat

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	Airport	
7.0	Nearest International Airport	Mumbai or Ahmedabad
8.0	Maximum Wind Velocity	62 Km/Hr 20-61 Km/Hr for 20 days per year Less than 20 Km/Hr for remaining period
9.0	Number of thunderstorm days	5 days per year
10.0	Max. relative humidity	87 %
11.0	Direction of prevailing wind	South – West
12.0	Maximum Recorded rain fall in 24 Hours	459.2 mm
13.0	Average annual rain fall	1203.5 mm
14.0	Max / Min temperature	45 / 5 Deg. C
15.0	Normal Barometric Pressure	1005 millibar
16.0	Maximum Barometric Pressure	1015 millibar
17.0	Minimum Barometric Pressure	999 millibar
18.0	Earthquake design criteria	Zone III according to IS : 1893 latest edition
19.0	Highest Flood Level	101.3 (Level 100 corresponds to 6m above MSL)

### 8.0 Statutory Approval:

The following statutory approvals are envisaged for implementation of the project wherever applicable:

- Chief Controller of Explosive (CCOE) / Petroleum and Explosives Safety Organization (PESO)
- Static & Mobile pressure vessel rules (SMPV)

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- Oil Industry Safety Directorate (OISD)
- Director General of Civil Aviation (DGCA)
- Ministry of Environment & Forest (MOEF)
- State Pollution Control Board (SPCB)
- State Electricity Board (SEB)
- Local Authorities
- Factory Inspectorate
- Legal Metrology Approval.
- Any other additional statutory approval required for fulfillment of the system.

#### 9.0 Codes and Standards:

Refer respective disciplines design basis for list of codes and standards.

#### 10.0 System Description:

Subsequent topics highlight various existing system descriptions at ONGC Hazira.

##### 10.1 LPG Loading

##### 10.1.1 Rail Loading :



LPG railway gantry is provided with a 12” LPG supply header from LPG dispatch pumps, 8” vapor return header connected to vapor balance line of LPG storage at sphere and 3” vapor vent header.

For each rail loading point, 3” pipeline tapping which is equipped with the below mentioned components has been taken from the 12” supply header.

##### Liquid Line

i.	3” Ball Valve	For complete isolation from the supply header
ii.	Pot	For removal of vapor as & when required
iii.	P.D. Meter	For the measurement of the quantity of LPG Loaded in Wagon

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iv.	3" 210 Control valve	Under command of Batch controller controls the flow rate during starting, stopping & normal loading as well as ensures loading only up to preset quantity
v.	3" Line Valve	For further isolation of the flexible loading arms, starting / stopping of the loading
vi.	3" Excess flow check valve	To shut off the flow in case of breakage of Loading arm
vii.	Chikson type Flexible loading arm	It connects the loading system to the wagon according to its position. The required flexibility for it is being provided by the swivel hammer union connection joints. A 2" valve is provided at the end of the arm. A 1/2" line along with valve and flexible hoses is also provided to vent off the trapped LPG between arm valves and wagon valve before disconnecting the arm from wagon

For vapor return from each loading point, 2" pipeline tapping has been taken from the 8" return header. It contains below mentioned components.

#### Vapor Line

i.	2" Valve	For complete isolation from the vapor return header
ii.	2" Excess flow check valve	To shut off the flow in case of breakage of Loading arm
iii.	Chikson type Flexible loading arm	It connects the vapor return system to the wagon according to its position. The required flexibility for it is being provided by the swivel hammer union connection joints. A 2" valve is provided at the end of the arm. A 1/2" line along with valve and flexible hoses is also provided to vent off the trapped LPG between arm valves and wagon valve before

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	disconnecting the arm from wagon
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Both the LPG loading and vapor return lines are connected with the 3" vent header through 1" line with valves to carry the venting as and when required for depressurization. The vent header is routed to an elevated cold vent stack located nearby at safe place and is continuously purged with Steam. It is also equipped with the flame arrestor.

The batch controller which is dual channel type used for LPG as well as Naptha loading is heart of the loading system. It displays the flow rate, quantity loaded in the wagon and remaining quantity to be loaded as per the pulses received from the PD meter. It controls the entire loading operation, starting and stopping (multi stage) by sending the commands to the control valve as per the logics set inside it.

#### 10.1.2 Rail Unloading

The provision for unloading LPG sick wagons have been made at two points in south rail gantry. A 2" high pressure fuel gas header is supplying the motive force to empty the LPG from sick wagon to LPG sphere, through the 3" LPG return header. The sick wagon has to be placed below the unloading point.

#### 10.1.3 Road Loading



LPG road gantry is provided with a 10" LPG supply liquid header from LPG dispatch pumps, 4" vapor return header connected to vapor balance line of LPG storage at sphere and 3" vapor vent header.

For each road loading point, 3" pipeline tapping which is equipped with the below mentioned components has been taken from the 10" supply header.

##### Liquid Line

i.	3" Ball Valve	For complete isolation from the supply header
ii.	Pot	For removal of vapor as & when required
iii.	P.D. Meter	For the measurement of the quantity of LPG Loaded in Truck

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iv.	3" 210 Control valve	Under command of Batch controller controls the flow rate during starting, stopping & normal loading as well as ensures loading only up to preset quantity
v.	3" Line Valve	For further isolation of the flexible loading arms, starting / stopping of the loading
vi.	3" Excess flow check valve	To shut off the flow in case of breakage of Loading arm
vii.	Chikson type Flexible loading arm	It connects the vapor return system to the truck according to its position. The required flexibility for it is being provided by the swivel hammer union connection joints. A valve is provided at the end of the arm. A 1/2" line along with valve and flexible hoses is also provided to vent off the trapped LPG between arm valves and truck valve before disconnecting the arm from truck

For vapor return from each loading point, 2" pipeline tapping has been taken from the 4" return header. It contains below mentioned components.

#### Vapor Line

i.	2" Valve	For complete isolation from the vapor return header
ii.	2" Excess flow check valve	To shut off the flow in case of breakage of Loading arm
iii.	Chikson type Flexible loading arm	It connects the vapor return system to the wagon according to its position. The required flexibility for it is being provided by the swivel hammer union connection joints. A 2" valve is provided at the end of the arm. A 1/2" line along with valve and flexible hoses is also provided to vent off the trapped LPG between arm valves and wagon valve before disconnecting the arm from wagon

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Both the LPG loading and vapor return lines are connected with the 3” vent header through 1” line with valves to carry the venting as and when required for depressurization. The vent header is routed to an elevated cold vent stack located nearby at safe place and is continuously purged with steam. It is also equipped with the flame arrestor.

The batch controller is heart of the loading system. It displays the flow rate, quantity loaded in the wagon and remaining quantity to be loaded as per the pulses received from the PD meter. It controls the entire loading operation, starting and stopping (multi stage) by sending the commands to the control valve as per the logics set inside it.

#### 10.1.4 Road Unloading

The provision for unloading LPG sick truck has been made at one point at the end of road gantry. A 2” high pressure fuel gas header is supplying the motive force to empty the LPG from sick truck to LPG sphere, through the 3” LPG return header. The sick truck has to be placed near the unloading point.



#### 10.2 HSD Loading :

HSD is dispatched through road tankers only and for dispatch, 2 nos. of loading points are provided in road gantry. The size of pipe line from pumps to loading gantry is 4”. Each loading point contains a 3” isolation valve, Turbine meter, 2” 210 Control valve, a flexible loading arm and a batch controller. The function of each component is similar to that of LPG loading gantry. After filling of required quantity of HSD, dip is checked to ensure proper filling on the road tanker. Actual quantity is taken as per dip only.

#### 10.3 SKO Loading

SKO is dispatched through road tankers only and for dispatch, 3 nos. of loading points are provided in road gantry. The size of pipe line from pumps to loading gantry is 4”. Each loading point contains a 3” isolation valve, Turbine meter, 2” 210 Control valve, a flexible loading arm and a batch controller. The function of each

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component is similar to that of LPG loading gantry. After filling of required quantity of SKO, dip is checked to ensure proper filling on the road tanker. Actual quantity is taken as per dip only.

#### 10.4 ATF Loading

ATF is dispatched through road tankers only and for dispatch 2 nos. of loading bays are provided in road gantry. The size of pipe line from pumps to loading gantry is 8". Each loading bay contains 3" isolation valve, Turbine Meter, 210 Control valve, batch controller and loading arm. The function of each component is similar to that of LPG loading gantry. After filling of required quantity of ATF, dip is checked to ensure proper filling on the road tanker. Actual quantity is taken as per dip only.



#### 10.5 Weighing System

##### 10.5.1 Road Weigh Bridge

There are 2 nos. of road weigh bridges one no. of 60 MT capacity & one no. of 50 MT. Normally weigh bridge no. 02 located near to shift In-charge room is utilized and weigh bridge no. 01 is kept as a stand by.

##### 10.5.2 Rail Weigh Bridge

The empty and filled wagons are weighed in motion by the load cell of pit type weigh bridges. There are two nos. of rail weigh bridges, one in operation and another as a stand by. The overall capacity on each system is 100 MT. The entire rake of wagons is weighed in motion. The approach velocity of the train is maintained below the speed limit of 3 Km/Hr. Their weight are then displayed on the digital indicator and the same input is given to the computer.

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## 10.6 Loading Transfer Pump details



Service	LPG Road Loading	LPG Rail Loading	SKO Road Loading	ATF Road Loading	HSD Road Loading	ATF / SKO / HSD Road unloading Sump Pump	Naphtha Rail Loading	Naphtha Rail unloading Sump Pump
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal
No. of Pumps	5	4	2	2	2	1	3	1
Flow Rate (M3/Hr)	80	300	58	190	35	10	1400	20
Differential Head (M)	57.1	86.6	46	46	32	53.8	130	32
Motor Rating KW	15	75	30	30	5.5	5.5	500	3.7

## 10.7 Proposed Scheme

### 10.7.1 Proposed Scheme shall have following design basis but not limited to

- The Rail and road gantry, all the equipment, valves, fittings, pipes etc. considered for replacement or refurbishing shall be dimensionally and rating wise dovetailed with the existing system.
- The revamping shall not affect the process parameters and operation procedure of the existing system except for up gradation.
- The design shall consider ease of execution with minimum shut down and hot work.
- The Latest OISD and CCOE norms shall be followed as per section 9 of the design basis.
- The design basis shall include the Integration with existing system
- The Latest technology methods as per standard Oil and Gas industry practice shall be followed.

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vii. The design shall include sequencing of activities in such a way that the transition to new system from old system is smooth and does not require any major shut down. Execution methodology is therefore necessarily to be discussed during pre-bid conference.

viii. Proposed execution Methodology

➤ At rail loading gantry, either of rail gantries (north or side) at a time shall be made available for execution.

➤ At Road loading gantry, half of the gantry at a time shall be made available for execution.

ix. New or modification of foundation and structure to be envisaged for equipment pipe and cable supports. The existing foundation and structure to be suitably designed for further loading. Existing cable tray route to be considered for new routing wherever possible.

x. The design shall be preferably consider as skid mounted for downstream of isolation valves with Electrical and instrumentation included on skid. Only the loading arms shall be integrated separately. This will ease of installation. The skid can be tested as independent unit.

xi. The New control room location shall be preferably located near the existing weigh bridge & common with the existing weighbridge control room.

xii. All NRVs being provided shall be flange type.

xiii. All isolation valves being provided shall be Ball valve type.



#### 10.7.2 LPG rail Gantry :

i. Replacement of 16 no Isolation valves of Strainers (8 no) in main 12" liquid line in between North and South Gantry.

ii. Replacement of drain / vent system of filters (8 no). The drain / vent system are not in operable condition and are badly corroded. It is to be replaced.



iii. Replacement of all Loading Points Isolation valves both in Liquid line and vapor line, Excess flow check valves both in Liquid line and vapor line, Liquid loading arm and Vapor return arm, drain and vent system along with associated piping and fittings.

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- iv. Replacement of Two nos. of Decanting Point liquid Loading arm and Vapor return arm on South side of South rail gantry.
- v. Installation of additional two nos. of decanting points facilities at north side of north rail gantry.
- vi. Repair / replacement of 120 nos. flapper bridges along with winch system and supporting concrete structure.
- vii. Replacement of flame arrestor in vent line with approach / ladder with proper working platform for two persons for facilitating repair / cleaning of flame arrestor in both the gantries – South and North.
- viii. Replacement of Gas Pressure regulator in Fuel line with suitable bypass / isolation arrangement.
- ix. Associated Electrical system.
- x. Modification in Structure to accommodate modified system.
- xi. One no. of Foundation Fieldbus based Pressure Transmitter each at LPG main header line of North Gantry and South Gantry.
- xii. One no of Foundation Fieldbus based Temperature Transmitter along with temperature element, required thermo well & accessories at LPG main header line North Gantry and also in south Gantry.
- xiii. Two nos. of Foundation Fieldbus based Pressure Transmitter at Vapor return line and fuel gas line at LPG decanting system.
- xiv. Replacement of existing flow meters by Coriolis based flow meters and integrating the same with the batch controllers which are further to be integrated with TAS.
- xv. Replacement of 5 no. batch controllers along with power on / off switch.
- xvi. All the existing digital set stop valves are to be refurbished (all SOV's, internals, tubing, spindles, indicators, isolation valves to be replaced).
- xvii. All differential pressure gauges of Strainers in between North and South gantry along with manifolds, isolation valves, impulse tubing and fittings are to be replaced with new 8 nos. of DPT's (Foundation Fieldbus based) and integrated with TAS.

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- xviii. Five (5) nos. of new ESD pushbutton stations (2 - South Gantry, 2 - North Gantry, 1 - Control room) to be installed and commissioned with associated cablings etc. Also, 8 nos. of Emergency push button for pump stop (4 - South Gantry, 4 - North Gantry) to be installed and commissioned with associated cablings etc.
- xix. Naphtha shutdown valve SOV to be replaced, SOV will be Manual latch type.
- xx. Open Path Gas detectors will be relocated as per OISD norms. Necessary structure required for mounting sensor will be provided.
- xxi. One no. of Power Junction box & Signal junction box for each batch controller.
- xxii. Supply of Power Distribution box as per Power distribution Scheme.
- xxiii. Supply of FF distribution box along with all required accessories.
- xxiv. Common Junction boxes for ESD push button stations.
- xxv. There are existing 76 no of dual channel type Batch controllers (DANLOAD 6000) out of which 20 no requires communication board, however, if any of communication board of other batch controllers were found to be nonfunctional; it shall be covered in the LSTK scope. Any association from OEM of batch controller for establishing connectivity to TAS shall be part of LSTK Scope.
- xxvi. Installation and commissioning of four nos. of new metering system for unloading similar to the existing loading bays (consisting of flow meter, excess flow check valve, isolation valves, associated cabling etc.) for the existing LPG decanting bays (two nos. in south gantry) and for the newly proposed decanting bays (2 nos.) at north gantry.
- xxvii. Provision for new rail sump (for naphtha product, capacity 33.7 m<sup>3</sup>) and pump & motor assembly with inter-connection with the existing sump & pump assembly.
- xxviii. Two no of Sump Level Transmitter and Level Switch (with High & Low level) will be provided for New & Existing sump for auto operation of sump motors and further integrated to TAS.

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- xxix. Damaged asbestos sheets to be replaced with suitable color coated Galvanized sheet.
- xxx. One of the bays in each gantry shall be so designed to accommodate two flow meters in series to enable checking of any meter with master meter. The proving facility shall be incorporated through TAS.
- xxxi. LPG rail loading arms at rail gantry are to be designed and installed such that the existing naphtha rail loading system remains unaffected and operational. There shall not be any fouling between the two loading systems – LPG and Naphtha.
- xxxii. Any change / modification in the existing structure required for fixing loading arms.
- xxxiii. Necessary repair job in the existing Civil / concrete portion wherever necessarily required.
- xxxiv. Supply of Ten sets of non-sparking tools.
- xxxv. One staircase at South end of the north gantry and another staircase at the north end of the south gantry in between strainer area are to be provided.
- xxxvi. LPG vent opening at the north and south gantry are to be provided with the steam and Inert Gas dilution system for dilution purpose.

### 10.7.3 LPG Road Gantry



- i. Replacement of all loading bay liquid line loading arm and vapor line arm.
- ii. Replacement of decanting bay liquid line loading arm and vapor line arm.
- iii. Replacement of isolation valves, excess flow check valves and associated piping and fittings in liquid line and vapor line and drain and vent system.
- iv. Replacement of earthing system and hook up with batch controller.
- v. Provisioning of Emergency Shut-Down Valve (ESDV) in 10” liquid line & 4” vapor line as per OISD Guidelines similar to existing rail gantry ESDV system.
- vi. Installation and commissioning of one no. of metering system for the existing LPG decanting bay similar to the existing loading bays (consisting of flow meter, excess flow check valve, isolation valves, associated cabling etc.).
- vii. One no of Pressure Transmitter at LPG main header line.

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- viii. One no of Temperature Transmitter along with temperature element, required thermo well & accessories at LPG main header line.
- ix. Replacement of all existing flow meters by Coriolis based flow meters and integrating the same with the batch controllers which are further to be integrated with TAS.
- x. Replacement of all old batch controllers by new controllers along with RIT and earthing system.
- xi. All the existing digital set stop valves are to be refurbished (all SOV's, internals, tubing, spindles, indicators, isolation valves to be replaced).
- xii. Each bay Batch controller will be provided with one no. proximity card reader which will be further interfaced with TAS.
- xiii. Three (3) nos. of new ESD pushbutton stations (2 - Gantry and 1- Control room) with associated cablings etc. to be installed and commissioned. Also, one no of Emergency push button for LPG pumps stop other than ESD push buttons to be installed and commissioned with associated cablings etc.
- xiv. Two no of Pressure Transmitter at Vapor return line and fuel gas line.
- xv. One no of Power Junction box & Signal junction box for each batch controller.
- xvi. Supply of Power Distribution box as per Power distribution Scheme.
- xvii. Common Junction boxes for ESD push button stations.
- xviii. Replacement of 4 nos of Isolation valves (8") of strainers (2 no) in liquid line after battery limit.
- xix. Replacement of drain / vent system of filters (2 no). The drain / vent system are not in operable condition and are badly corroded. It is to be replaced.
- xx. All differential pressure gauges of Strainers after Battery limit along with manifolds, isolation valves, impulse tubing and fittings are to be replaced with new 2 nos. of DPT's (Foundation Fieldbus based) and integrated with TAS.
- xxi. Since the road loading shall be used for custody transfer metering, there shall be suitable proving facility to be provided as per the standards.
- xxii. Replacement of 1 no. flame arrestor in vent line with approach / ladder with proper working platform for two persons for facilitating repair / cleaning of flame arrestor in LPG Road Gantry.



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#### 10.7.4 ATF / SKO / HSD Road gantry

- i. Provision for stand-by road sump (for ATF / SKO / HSD products, capacity 16.9 m<sup>3</sup>) and pump & motor assembly with inter connection with the existing sump & pump assembly.
- ii. Provision of new loading arm for SKO road loading bay no. 6. Existing loading arm at the bay no. 6 is to be shifted to ATF bay no. 2.
- iii. One no of Pressure Transmitter to be installed in the header line of HSD, ATF and SKO each (total 3 nos.).
- iv. One no of Temperature Transmitter along with temperature element, required thermo well & accessories to be installed in the header line of HSD, ATF and SKO each (total 3 nos.).
- v. Replacement of all existing flow meters (turbine meters - 5nos. in HSD & SKO) by Coriolis based flow meters and integrating the same with the batch controllers which are further to be integrated with TAS.
- vi. Replacement of all old batch controllers (5 nos.) by new controllers along with RIT and Earthing system.
- vii. All the existing digital set stop valves (5 nos.) are to be refurbished (all SOV's, internals, tubing, spindles, indicators, isolation valves are to be replaced.)
- viii. Each bay will be provided with one proximity card reader further interfacing with TAS.
- ix. Three (3) nos. of new ESD pushbutton stations (2 nos. at Gantry and 1 no at Control room) with associated cablings etc. to be installed and commissioned. Also, 3 nos. (one each for ATF, SKO & HSD) of Emergency push buttons for pumps stop ( at POL Gantry) other than ESD push buttons to be installed and commissioned with associated cablings etc.
- x. Two nos. of Level transmitters and Level Switches (High & Low) for New and existing sump for auto operation of sump motors and further integrated to TAS.
- xi. One no of Power Junction box & Signal junction box for each batch controller.
- xii. Supply of Power Distribution box as per Power distribution Scheme.
- xiii. Common Junction boxes for ESD push button stations.

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- xiv. Provision of Emergency Shutdown Valve (ESDV) facility in all the three products (8" for ATF, 4" for SKO and HSD) lines.
- xv. Provision of suitable facility for verification / cross checking of tanker compartment volume for POL products ( i.e. HSD/SKO/ATF)
- xvi. Supply installation and commissioning batch controllers for ATF loading bays will not be part of this project. However, power & communication cabling and any other hardware/software, integration and configuration necessary at TAS end for smooth ATF product loading shall be in LSTK scope under this project.
- xvii. Since the road loading shall be used for custody transfer metering, there shall be suitable proving facility to be provided as per the standards.

## 10.7.5 AUTOMATION

### 10.7.5.1 TERMINAL AUTOMATION SYSTEM (TAS)

- i. Complete Hardware and software for Terminal automation system.
- ii. Network switches, Media convertors, Patch chords, communication modules, Firewall, etc.
- iii. Servers & Human Machine interface unit along with Printers
- iv. Integration of all batch controllers along RIT & Earthing Logic (Road & Rail) with TAS
- v. Integration with barrier gate, & card reader (Road Gantry including ATF)
- vi. Truck Display unit for each bays' of road gantry, related parking & dispatch area.
- vii. Integration with Existing weigh bridges. (2 Nos. - Road & 2 Nos. - Rail)
- viii. Integration with F&G System, Shifting of all gas detector panels in new control room and re- commissioning the same.
- ix. Repeat of the above gas detection alarm signals from new control room to LPG control room by extending HMI Network & station up to LPG control room.
- x. Integration of existing custody transfer meters i.e. IOCL SKO mass flow meter (01 no), KRIBHCO mass flow meters (02 no), BPCL mass flow meter (01 no),

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TFM flow computers\_Naptha to SBM (02 no), LPG CTMS , Naptha CTMS and LPG PLT to HPCL.

- xi. Integration with existing MIS, SAP, Fire Detection Alarm System.
- xii. Replacement of Complete ESD Scheme
- xiii. Hardwired Interface between TAS & FW ROV system
- xiv. Complete software for TAS system.
- xv. License for Hardware & Software.
- xvi. SIL-2 Control System (I/O Modules, Power Modules, Communication Modules, Field bus interface modules, Relays, Terminal blocks, Panels, etc.) for ESD, Field Instrument & Third party interfaces.
- xvii. Foundation Fieldbus software & hardware for Rail Gantry DPT's, PT's & TT's.
- xviii. Marshaling Panel for F&G system at Existing location
- xix. Complete Power Distribution for Batch controller, Earthing relays, Flow meters, TAS, Existing HMI's, Flow Computers, FW ROV's, Weigh Bridge (road & Rail) and F&G System, etc..
- xx. Third party software & integration with TAS system along with required hardware at both the ends.
- xxi. Antivirus system license.
- xxii. Billing for Road gantry shall be done by automation system. However manual billing practice shall also be made available.
- xxiii. Billing for Rail gantry shall be done by weigh bridge data.
- xxiv. Control of loading functions / process with control of valves.
- xxv. Flow measurement & recording.
- xxvi. Readouts / printouts of total quantities loaded for each truck / wagon.

#### 10.7.5.2 **SHIFTING OF EXISTING FACILITES TO NEW CONTROL ROOM AS LISTED BELOW:**

- i. MIS System
- ii. FW ROVs Panels
- iii. Gas Detection Panels & repeating GD alarms at main control room
- iv. TFM Flow Computers (2 nos.)

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- v. BPCL Flow recorder (1 no.)
- vi. LPG Skid flow computer.
- vii. Naphtha Skid flow computer.
- viii. CTMS-COM-network panel.
- ix. Any other equipment required.

#### 10.7.5.3 CABLES:

Supply, laying, termination and commissioning of power, control, signal cable with cable glands as listed below:

##### **Power cables**

- i. Main UPS DB to Field Power Distribution Boxes (PDB's)
- ii. UPS DB to Existing Equipment's
- iii. UPS DB to TAS Equipment's
- iv. Field PDB to Power Junction Boxes (PJB) for individual bays
- v. PJB to Batch Controller Unit (BCU)
- vi. PJB to Coriolis Based Mass Flow meter
- vii. PJB to Earthing Relay
- viii. PJB to RIT.

Any other cable required to fulfill the completeness of automation of Road & Rail Gantry Operation shall be scope of LSTK Bidder.

##### **Signal Cables**



- i. Coriolis Based Mass Flow meter (CFM) to BCU.
- ii. Field Instruments (Road Gantry) to TAS.
- iii. Field instruments (Rail Gantry) to TAS.
- iv. FW ROV Panel to TAS.
- v. F&G detector cables for open path.

Any other cable required to fulfill the completeness of automation of Road & Rail Gantry Operation shall be scope of LSTK Contractor.

##### **Control Cables**

- i. BCU to Digital Set-Stop Valve
- ii. BCU to RIT station

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- iii. Earthing Relay to BCU
- iv. ESD Push Buttons (Rail & Road Gantry) to TAS
- v. Naphtha Pressure Control Valve cum shut down valve to TAS (DI & DO)
- vi. ESDV's to TAS
- vii. ESD to TAS
- viii. ESD to Rail LPG Transfer Pump MCC's
- ix. ESD to Road LPG Transfer Pump MCC's
- x. ESD to Product (ATF/SKO/HSD) Transfer Pump MCC's
- xi. MCC to TAS.
- xii. New Marshaling Panel (F&G) to F&G at New control room

Any other cable required to fulfill the completeness of automation of Road & Rail Gantry Operation shall be scope of LSTK Contractor.

#### **Communication Cables**



- i. Batch controller unit to Local terminal server
- ii. Terminal server to TAS
- iii. TAS to weigh Bridge (2 no's Road & 2 no's Rail)
- iv. TAs to MIS & SAP
- v. HMI Network Extension up to LPG Control Room
- vi. Barrier gate to TAS
- vii. Truck Display Unit to TAS
- viii. Card Reader to BCU
- ix. Field Bus Instrument to TAS

Any other cable required to fulfill the completeness of automation of Road & Rail Gantry Operation shall be scope of LSTK Contractor.

#### **10.7.5.4 New Control Room**

- i. Design and construction of New control as per OISD norms.
- ii. Air conditioning of control room.
- iii. Confinement of road gantry
- iv. LED Based lighting to maintain illumination as per OSID norms.
- v. Air Conditioning Power Supply shall be separate from Lighting Power supply.

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- vi. Timer Based area lighting control.

**10.7.5.5 NOTE:**

- i. Requirements indicated above are indicative minimum. LSTK Bidder to confirm that they will provide the Terminal Automation system to meet the system requirement.
- ii. LSTK contractor to make sure that all site requirements shall be part of their scope of work. Any site visit required for clear understanding of site requirements shall be made by LSTK contractor.
- iii. Scope defined above is brief scope of work for LSTK contractor, however to understand the actual work involved as per site condition, LSTK contractor has to make a site visit for clear understanding of scope of work involved.
- iv. Any discrepancy at later stage after award of contract shall not be entertained / allowed.
- v. Suitable electronic gadgets shall be provided for control rooms.
- vi. Future requirements shall be taken care by LSTK contractor.
- vii. LSTK contractor to follow the scheme provided, however all these schemes are indicative for the brief scope of work & brief understanding of work involved only by LSTK contractor.
- viii. Canopy shall be provided as required.
- ix. Electrical power shall be made available at one place for each gantry. Further distribution shall be made as required.
- x. All cabling between dispatch area and respective control room / equipment's shall be part of LSTK contractor's scope of work.
- xi. Necessary earthing shall be part of LSTK contractor's scope of work.
- xii. Any electronic earthing requirements shall be provided by LSTK contractor.
- xiii. Process data shall be verified by LSTK contractor during site visit for actual verification.
- xiv. Hazardous area classification shall be followed as per product requirement.
- xv. Brief codes & standards are highlighted elsewhere in the specification; however LSTK contractor has to follow all applicable codes & standards as

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required.

#### 10.7.6 Electrical



- 10.7.6.1 Replacement of 310 nos. FLP W MLL with 125 W, FLP, HPMV lamps with complete fitting, control gear and separate copper ballast.
- 10.7.6.2 Installation of 250 nos. 4 way lighting junction boxes with socket head arrangement.
- 10.7.6.3 Replacement / installation of 7 nos. of minimum 12 way FLP lighting distribution board with incomer arrangement of MCCB / MCB and MCB in outgoing circuit.
- 10.7.6.4 Replacement of 6 nos. 250 W FLP HPMV lamp fitting with control gear with copper ballast.
- 10.7.6.5 Installation of 2 nos. 30 meter high mast (identical to the existing high masts) light with 2 X 400 W, HPSV, 18 nos. light fittings with flame proof lighting feeders for road gantry. PCC area shall be approximate 75 sq. mm. around high mast and it shall cover feeder pillar also. Each Lighting mast shall be fed through separate lighting transformer.
- 10.7.6.6 Shifting of the existing power source for lighting in the Gantry area from existing location to the new MLDB located at new control room.
- 10.7.6.7 Minimum 2 nos. flameproof welding and lighting receptacles with canopy in road gantry area.
- 10.7.6.8 Flameproof welding and lighting receptacles with canopy in rail gantry area at a maximum interval of 40 mtr.
- 10.7.6.9 Power cables, control cables and signal cables with associated erection hardware.
- 10.7.6.10 Associated electrical integration with the existing system.
- 10.7.6.11 1 no. hydraulically operated and 1 no. manually operated rail mounted maintenance trolleys with breaking facility for rail gantry area lighting shall be provided. Each Trolley shall be capable of carrying 3 persons at a time.
- 10.7.6.12 1 no. hydraulically operated, LCV mounted maintenance trolley with breaking facility for road gantry area lighting shall be provided. Each Trolley shall be capable of carrying 3 persons at a time.

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**ANNEXURE - I**  
**CIVIL AND STRUCTURE**

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## 1.0 General

The engineering design basis defines the minimum design criteria that shall form the basis for preparation of technical bid document and detailed civil, architectural and structural design of all structures Truck & Wagon Loading / Unloading Gantry sheds & foundations, Cable racks, plant buildings (like gantry building / platforms for gantry loading / MCC - Control Room), pump foundations etc.

This document also includes the design criteria that shall form the basis for carrying out design and engineering of items under general civil viz. roads, cable trenches, culverts, paving, drainage, fencing etc.



## 2.0 Design Codes:

### 2.1. Loads:

IS 875 : Part 1 : 1987	Code of practice for design loads ( other than earthquakes) for buildings & structures ,Part 1 – Dead loads
IS 875 : Part 2 : 1987	Code of practice for design loads ( other than earthquakes) for buildings & structures ,Part II – Imposed loads
IS 875 : Part 3 : 1987	Code of practice for design loads ( other than earthquakes) for buildings & structures ,Part III – Wind loads
IS 1893: -1984  - Pt I , 2002  - Pt II , 2005	1984- Criteria for earthquake resistant design of structures  Part 1, 2002– Code of practice for earthquake resistant design of structures – General Provisions & buildings  Part IV, 2005- Code of practice for earthquake resistant design of structures –Industrial structures including stack like structures.
IS 4326 :1993	Code of practice for earthquake resistant design and construction of buildings.

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### 2.2. Concrete Design:

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IS 456 – 2000	Plain & Reinforced Concrete - Code of practice
IS 13920 :1993	Ductile detailing of Reinforced Concrete Structures subjected to Seismic Forces – Code of Practice
IS 3370 Parts I – 1965	Code of Practice for concrete structures for storage of liquids :
IS 3370 Parts II – 1965	Part I - General Requirements
IS 3370 Parts III – 1967	Part II – Reinforced Concrete Structures
IS 3370 Parts IV – 1967	Part III – Pre stressed concrete structures
All 4 parts reaffirmed in 1999.	Part IV – Design Tables
IS 432 :Part I – 1982	Part I – Mild Steel And Medium Tensile Steel Bars
IS 1786 :1985	Specification For High strength deformed steel bars and wires for concrete reinforcement



### 2.3. Structural Steel Design:

IS 800 :2007 for allowable (Working) stress design	General construction in steel – Code of practice
IS 806 :1968	Code of practice for use of structural steel tubes in General Building Construction
IS 1161 :1998	Code of practice for steel tubes in general building construction
IS 4991 – 1968	Criteria for blast resistant design of structures for explosions above ground

### 2.4. Roads, Culverts, Drainage & Pavement Design:

IRC 5 -1998	Code of practice for roads & bridges
IRC 6 -2000	Code of practice for roads & bridges, Section II Loads & Stresses
IRC 37 -2001	Guidelines for the design of flexible pavements
IRC 58 -2002	Guidelines for the design of rigid pavements
IS 1172 -1993	Code of basic requirements for water supply, drainage &

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	sanitation
IS 1742 -1983	Code of practice for building drainage
IS 2065 -1983	Code of practice for water supply in buildings
IS 8835 -1978	Guidelines for design of surface drains

## 2.5. Foundation Design:

IS 1080 :1985	Code of practice for design & construction of shallow foundations in soil
IS 1904 :1986	Code of practice for design & construction of foundations in soil general requirements
IS 2950, Part 1 1981	Code of practice for design & construction of raft Foundations, Part I - Design
IS 2911 Pt. 1 Section- I 1979	Code of Practice for Design and Construction of Pile Foundation.- Driven Cast in situ concrete pile
IS 2911 Pt. 1 Section- II 1979	Code of Practice for Design and Construction of Pile Foundation. – Bored cast in situ piles
IS 2911 Pt. IV 1985	Code of Practice for Design and Construction of Pile Foundation – Load test on piles
IS 6403 :1981	Code of Practice for determination of bearing capacity of shallow foundations



## 2.6. Masonry Design:

IS 1905 :1987	Code of practice for structural use of un-reinforced masonry
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## 2.7. Misc. Standards:

OISD-STD-163 -Sept.2004	Safety Of Control Room For Hydrocarbon Industry
OISD-STD-164 -July 1998	Fireproofing in Oil & Gas Industry Safety Factory Rules
OISD-STD-118 -July 2008	Layouts for oil and gas installations

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OISD - STD / GDN - 115- July 2000	Guidelines on Fire Fighting Equipment and Appliances
OISD-STD-116-July 2008	Fire Protection Facilities For Petroleum Refineries
OISD-STD-117-July 2008	Fire Protection Facilities For Petroleum Depots, Terminals, Pipeline Installations and Lube Oil Installations
OISD-STD-173-Sept.2003	Fire Prevention and Protection System For Electrical Installations.

### 3.0 General Topography & Climatic Conditions

Please refer "Design Basis" Sr. no. 07 – Site Information for general topography and climatic condition.

### 4.0 Construction Features

The proposed new control room buildings will be R.C.C. frame type buildings. The building will be designed based on the OISD norms. There will be false flooring in the new control room which acts as a cable cellar for control room. All panels will be located above false floor. Control room will be equipped with Air conditioning system with 100 % redundancy.


All cables will be run either on structure or through cable trench or will be run on concrete pedestal / sleeper depending upon the site. All underground cable trenches will be of RCC type. Road crossing of cable trench will be provided by RCC culvert.

### 5.0 Design Loads

#### 5.1 General

5.1.1 Structures shall be designed to have sufficient structural capacity and integrity to resist safely and effectively all loads and effects of load combinations that may reasonably be expected.

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5.1.2 The design loads used for the structures, buildings and foundations shall conform to the requirements of the governing codes and specifications. As a minimum the design loads shall include dead load, operating loads, live load, rain load, wind load and seismic load. Where ever applicable, the design loads shall also include thermal load, anchor load, hydro test load, impact load, vibration load, surcharge load and bundle pull loads.

5.1.3 The units to be used for design and drawings are SI units.

## 5.2 Dead Loads

5.2.1. Dead load comprises of the weight of all permanent construction including walls, fireproofing, floors, roofs, partitions, stairways, fixed services and other equipment excluding their content.

5.2.2. Dead loads shall consist of total load due to the structure (framing, walls, roofing etc.), equipment, piping, insulation, refractory, overburden soil, and any other load permanently supported by the structure. If In-situ hydro test is planned, the dead load shall include water filled vessels and piping. Foundation dead loads shall contain the weight of the soil immediately above the foundation.



## 5.3 Static & Dynamic Equipment Empty Loads

5.3.1. Equipment loads shall be provided by Vendor, vendor drawings and / or data sheets and shall include empty weight.

5.3.2. The empty weight of the static process equipment including all fixtures, platforms, ladders, attached piping, pipe supports & insulation (if applicable) shall be considered. If piping weight is not indicated separately or included in the weight of the equipment, the same shall be considered as 10% of the weight of the equipment. The empty (dead) weight shall be considered as per inputs received from vendors. Static equipment's viz. Vessels, tanks etc.

5.3.3. Dead / Empty Weight of equipment – Weight of dynamic / rotary equipment like pumps / motors, D.G. Sets, and skid-mounted equipment shall be derived as far as possible from manufacturer's data and includes piping data. Insulation installed on piping and equipment shall be also considered.

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5.3.4. Empty / dead weight – Fabricated / Erected equipment weight from manufacturer’s data.

#### 5.4 Equipment Operating Loads

5.4.1. Operating Weight of equipment – Weight of equipment like pumps, tanks and vessels shall be derived as far as possible from manufacturer’s data and includes mechanical / piping data. Insulation installed on piping and equipment shall be also considered.

5.4.2. The operating loads for the process and utility equipment, including piping, shall be the dead loads plus weight of the liquid / contents under normal conditions at maximum operating level. Permanent stored materials for operation shall be included as operating loads.

5.4.3. Vessels, Tanks etc. – The weight to be included in the calculations depend on the extent to which it is filled with liquid.

5.4.4. Operating weight = Weight of the maximum contents of the equipment during operating condition of plant plus the empty weight.

#### 5.5 Equipment Hydro-Test Load

5.5.1. Hydrostatic test load = Weight of Full volume of the water filled in Equipment plus the empty weight of the equipment.

5.5.2. Equipment hydro test loads shall consist of the equipment empty weight plus the weight of the test content (usually water) contained in the system to be considered.

5.5.3. Foundation design to take account of:

- Fully dressed load with hydro test.
- Undressed condition with worst wind load effects.



5.5.4. For hydro testing of vessels, piping and the like allow for test case full of water.

#### 5.6 Piping Loads for Pipe Supports / Trestles

5.6.1. Pipe loads in Operating Condition shall be considered as follows:

- Up to 300 mm diameter - 1.0 KN/ Sq. m Dead Load (Self weight)  
1.8 KN/ Sq. m Live Load (Contents weight)

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- 300 mm dia. and over - Consider individual/actual point loads as per piping inputs

5.6.2. For pipe racks, where actual loads from pipes are used, they shall not be less than 2.0 KN/ Sq. m on each level.

5.6.3. Friction Force (Longitudinal & Transverse)

Longitudinal & transverse friction force in (both directions) 10 % of design vertical load of pipes for four or more pipes supported on a tier. (This is done due to reversible flow directions and forces)

Longitudinal friction force (30 % of design vertical load of pipes) & transverse force (10 % of design vertical load of pipes) for single to three pipes supported on a tier for global design whereas for local beam member design for single pipe frictional force of 30% to be considered in longitudinal and transverse direction or as per piping/stress load inputs. The local beam member design shall not be combined with seismic/wind loads.

5.6.4. For Pipe-racks; longitudinal friction force shall be considered as uniformly distributed over the entire span of the beam at each tier and transverse friction force shall be considered as a concentrated load at each tier level.

5.6.5. Friction forces on T-supports & trestles shall be considered as longitudinal 30% of the vertical loading & transverse 10% of the vertical loading. Both longitudinal and transverse friction forces shall be considered to act simultaneously.



5.6.6. Electrical and Instrumentation information shall be investigated to determine the approximate weight, location of the electrical trays and/or conduits. A minimum weight of 1.2 KN/ Sq. m shall be used for single level trays and 3.0 KN/ Sq. m for double trays, regardless of the tray width.

5.6.7. Special consideration shall be given to unusual loads such as large valves, unusual piping or electrical configurations, etc.

5.6.8. Anchor loads shall be as per the Stress analysis piping loads provided by Stress Group.

5.6.9. If no Stress analysis piping loads is available at the time of design, the following minimum anchor loads shall be used:

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- For pipe rack span less than 3600mm, apply 5 KN at the middle of the span;
- For pipe rack span more than 3600mm, apply 5 KN at 1/4 and 3/4 of the span;

## 6.0 Design requirements for pipe rack



### 6.1 Vertical Loading

Actual weights of pipes coming at each tier shall be calculated. In calculating the actual weight of pipe, the class of pipe, material content and insulation, if any, shall be taken into consideration. The total actual weight calculated shall be divided by the actual extent of the span covered by the pipes to get the uniform distributed load per unit length of the span. To obtain the design uniformly distributed load over the entire span, the UDL (uniformly distributed load) shall be assumed to be spread over the entire span. However, minimum loading for any pipe rack shall not be less than 2.0 KN/m<sup>2</sup>. In case, the calculated loading is higher than 2.0 kN/m<sup>2</sup>, this shall be rounded off to the nearest multiple of 0.25 (i.e. 2.25, 2.50, 2.75 kN/m<sup>2</sup>).

### 6.2 Friction Force (Longitudinal and Transverse)

Where the pipes are of similar diameter and service condition, the friction force at each tier on every portal, both in longitudinal and transverse directions shall be 10% of the design vertical loading of the pipes for four or more pipes supported on a tier for global design, and 30% of the design vertical loading of the pipes in longitudinal direction & 10% of the design vertical loading of the pipes in transverse direction for single to three pipes supported on a tier. Longitudinal friction force shall be considered as uniformly distributed over the entire span of the beam at each tier and transverse friction force shall be considered as a concentrated load at each tier level. Friction force on T-supports and trestles shall be taken as 30% and 10% in longitudinal and transverse directions respectively of the vertical loading. Both longitudinal and transverse friction forces shall be considered to be acting simultaneously. For local beam / member design shall be checked for frictional

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forces 30% of the vertical loads in both longitudinal and transverse directions acting simultaneously.

6.3 Anchor and Guide Force (Thermal load), if any

The Anchor or Guide Forces in longitudinal and transverse directions shall be as per piping inputs.

6.4 Loading on Intermediate Beam at Tier Level

Intermediate beam at tier level shall be designed for 25% of load on main portal beams in transverse direction. A reduction of 10% in vertical loading shall be considered for main portal beams if intermediate beams are provided.

6.5 Loading on Longitudinal Beams

Longitudinal beams connecting portal columns shall be sufficiently strong to sustain 50% of the load on the transverse beams. This total load shall be assumed as two equal concentrated loads acting at 1/3rd span. Other longitudinal axial forces coming on it from the design of the supporting system shall also be simultaneously taken into account in the design of the longitudinal beam.

6.6 Cable Tray / Ducts and Walkway Loads

The estimated actual load from electrical trays and instrumentation ducts shall be considered at the specified locations, together with walkways, if provided.



6.7 Wind Force

Transverse wind loading shall be calculated depending on the width of the Pipe Rack as follows:

Basic wind pressure shall be considered as per IS: 875.

To calculate wind load in transverse direction of pipe-rack, a projected height of 1.25m/1.5m/2.0m shall be considered on all tiers irrespective of height between two tiers of rack widths of 4m/6m/8m and 10m respectively. For pipe-racks of widths greater than 10m, the above projected height shall be taken as 0.8[diameter of

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largest pipe including insulation (m)] + tan 10° [width of rack (m)]. However, this shall not exceed the height between consecutive tiers.

## 7.0 Live Loads

### 7.1. General

Live loads shall consist of loads due to the intended use and occupancy of the structure. Minimum live loads due to use and occupancy shall be as follows, unless otherwise specified on process / assignment drawings. Reduction in Live load shall be per Cl 3.2 of IS: 875 – Part II.

Area	Specified Uniform Loads (KN/m2)*	Specified Point Loads(KN)**
Ladder Rungs	0	2.2
Office floor, labs, walkways	5.0	9.0
Minimum roof load	1.5	3.75
Operating, maintenance, platform	5.0	6.7
Suspended piping on main roof	1.0	none
Access platform	3.0	none
Electrical, computer and control room	10.0	9.0
Toilet bathroom	2.0	9.0
Stair / Corridors / Passages	5.0	4.5



\* Minimum specified uniform loads and minimum specified concentrated loads do not act concurrently.

\*\* Distribute concentrated loads over 300mm x 300mm area. For evaluation of local effects of crushing (Ref. Cl 3.1.1 IS 875 Part II).

For railings, a horizontal force of 1.0kN at any one point or uniform load of 0.75kN/m shall be used.

### 7.2. Live Loads on Different Structures / Building

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Live loads shall, in general, be as per IS: 875. However, the following minimum live loads shall be considered in the design of structures to account for maintenance and erection as well:

➤ Service Platform		
Vessel / Tower	-	3.0 KN/m <sup>2</sup>
Isolated platform (for valve operation)	-	3.0 KN/m <sup>2</sup>
Access way	-	2.5 KN/m <sup>2</sup>
Cross over	-	2.0 KN/m <sup>2</sup>
➤ Substation / Control Room		
Panel floor	-	10.0 KN/m <sup>2</sup>
Partitions	-	1.0 KN/m <sup>2</sup>
➤ Office building		
Office area	-	3.0 KN/m <sup>2</sup>
Lobby	-	5.0 KN/m <sup>2</sup>
Exit way	-	5.0 KN/m <sup>2</sup>
Partitions	-	1.0 KN/m <sup>2</sup>
➤ Staircase		
Office	-	5.0 KN/m <sup>2</sup>
Substation / Control Room	-	5.0 KN/m <sup>2</sup>
Laboratory	-	3.0 KN/m <sup>2</sup>
Service platform	-	2.5 KN/m <sup>2</sup>


## 8.0 Earth pressure (H) & Buoyancy

For evaluating earth pressure on walls of trenches and pits co-efficient of earth pressure at rest shall be considered, its minimum value being taken as 0.5. If a higher value is obtained from soil characteristics, the same shall be adopted.

Temporary rise of ground water level shall be duly considered and hydrostatic pressure arising there from shall be considered for design of trenches, pits and basements more than 1.25 m in depth.

## 9.0 Wind Loads

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Wind loads shall be in accordance with the applicable codes, specifications and recommended practices listed in IS 875, Part III.

#### 10.0 Seismic Load

Seismic load induced on structures, buildings, equipment and foundations shall be calculated in accordance of the requirements the IS standard as mentioned in “Design Codes”.

Factors for the calculation of the seismic loading, i.e. seismic zone, soil profile, etc. shall be as per Geotechnical Investigation and in accordance with the requirements of the IS standard as mentioned in Section “Design Codes”.

#### 11.0 Impact Loads

Impact loads shall be calculated in accordance with the requirements of IS: 875 (Part 5) and IS: 2974 codes. For loads being given by equipment supplier, impact loads shall be as per information given on civil assignment drawing of equipment supplier. Impact loads shall be considered for local member design & it shall not be used with wind/seismic load cases.

#### 12.0 Vibration Loads

Vibration loads shall be as per manufacturer’s recommendations & Indian standards.



A three-dimensional vibration analysis for rotating equipment foundations shall be done to satisfy manufacturer’s recommendation if any, and provisions of Indian standards.

The natural frequency of the supporting structures and foundations shall be below 80 % or above 120 % of the natural frequency of the machine in the first mode.

#### 13.0 Surcharge / Overburden Loads

Surcharge loads shall be considered for structures (tanks, pits etc.) and walls retaining soil, if any, in addition to usual soil pressure.

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Surcharge pressure shall be generally considered as 15kN/m<sup>2</sup> on top slab and also on adjacent ground.

## 14.0 Concrete Structures – Design

### 14.1. General

All structures shall be analyzed / designed in mainly in limit state as per IS: 456-2000, by allowable stress design as per IS 3370. Generally the concrete beam members shall be designed to meet the deflection criteria as given below:

- Deflections in concrete structures shall be limited by adherence to the limits on span/depth ratio for beams, slabs & length/lateral dimensions for columns as specified in IS: 456.
- For concrete structures (Ref. Cl 23.2.1 of IS 456: 2000):
 

For cantilever beams	7 mm
For simply supported beams	20 mm
For continuous beams	26 mm
- Calculated vertical deflections for structural members shall not exceed the following:
 

Total vertical deflection due to all loads including the effects of temperature, creep & shrinkage =  $\text{Span}/250$
- The calculated lateral deflections due to load combinations for building shall not exceed the following:
 



Occupied buildings =  $h/250$

Wall stanchions =  $h/350$  or 20 mm whichever is less

### 14.2. Foundations

All major foundations shall be piled Foundations. For minor structures shallow spread foundations or mat / raft foundations shall be designed if specified in soil report.

### 14.3. Concrete Grade

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The minimum M30 grade of reinforced cement concrete shall be used for all structures and foundations except for grade slabs / paving for which M20 may be used. Severe condition of exposure as per IS: 456 shall be considered for concrete mix designing for all RCC structures except for RCC in pavements which shall be designed for moderate exposure condition.

If soil investigation report recommendations require a higher cement content and / or specific type of cement the same shall have precedence.

75 mm thick lean concrete of grade M10 (nominal mix) shall be provided under all RCC foundations except under base slab of liquid retaining structures where 100 mm thick concrete of mix M-10 (nominal mix) shall be used. The lean concrete shall extend 75 mm beyond the foundation for normal foundations and under liquid retaining structures.

Concrete for encasing shall be M20 with 10 mm down aggregate.

Plain cement concrete (PCC) of grade M10 (nominal mix) of minimum 150 mm thickness shall be provided under all masonry wall foundations.

#### 14.4. Reinforcement Bars

High strength deformed steel bars of grade Fe 500 conforming to IS: 1786 shall be used. M.S. round bars (Grade-I) conforming to IS: 432 may be used for holdfasts of inserts.

#### 15.0 Steel Structure Design



All steel structures shall be designed as per IS 800- 1984 (2007).

All structures shall be framed in transverse direction and braced in longitudinal direction. Both induced stresses and deflection shall be kept within provisions of IS codes & good engineering practices.

The minimum thickness of structural sections shall as given below;

Trusses / bracings	-	6 mm
Purlins, side girts/runners	-	6 mm

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Columns, beams	-	7 mm
Gussets in trusses & girders		
Up to & inclusive of	-	12 m span 8 mm
Above 12 m span	-	10 mm
Stiffeners	-	8 mm
Base-plates	-	12 mm
Chequered plates	-	6 mm on plain
Grating	-	25 mm
Grout for structural columns	-	As required but minimum 25 mm
Grout for equipment	-	As required but minimum 40 mm

## 16.0 Paving

The surface treatment for the various areas shall be provided as listed below.



Roads	-	Asphalt (Bituminous) paving
Approach to Units & control room	-	Asphalt (Bituminous) paving
T/T Loading Gantry Shed approach	-	Asphalt (Bituminous) paving
T/T Loading Gantry Shed	-	200 mm thick RCC M20 paving
Maintenance / Dropout / Loading / Unloading / Vehicular movement area	-	200 mm thick RCC paving

Generally, the slope of the paving towards drain side shall be 1:100 but the maximum drop in paving shall be limited to 150 mm. Two way slopes in paving shall be avoided as far as possible.

## 17.0 Roads

All roads shall be asphalt roads and shall be designed for heavy vehicular traffic movements per IRC loadings. Main plant road widths shall be 8 m inclusive of 0.75 m wide shoulders on either side. The internal access roads to individual areas shall be minimum 4.0 m wide with 0.75 m wide shoulders. Design life of the same shall be 15 years (Ref. Cl 3.3.3 IRC 37-2001- 'pavements for Nationals and State highways shall be designed for a life of 15 years').



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## 18.0 Drain

- 18.1. Surface drainage includes all surface water discharge from clean plant areas attributable to rainwater, firewater and open surface water drains, trenches and natural water courses to ultimate discharge point avoiding accidental oily contaminated water system.
- 18.2. Drain section shall be rectangular type in and around units and in other areas. Material of construction shall be brick drains with 20thk. Cement mortar plaster (1:4) and neat cement punning shall be provided.
- 18.3. Hot dipped Galvanized electro forged steel grating covers, or pre-cast RCC (M20) covers of designed thickness, hand railing, chain link fencing wherever necessary shall be provided to minimize the risk of falls by personnel. Oil water separator shall be provided with trenches, sumps, valves and pipes including connecting to nearest OWS network for disposing the collected oil to OWS. The separated oil to be transferred to slope tank and the remaining water to the nearest storm water drain outlet.
- 18.4. Slope of main drain along shall be 1:1000. Slope of secondary drain shall be 1:750.
- 18.5. Storm water drains shall be sized for the higher discharge arising out of either rain water or firefighting water and shall be connected to existing drain of adequate capacity.
- 18.6. Rain water run-off shall be computed by the formula:-  
 $Q = (KIA)/360$  where,  
K= Surface run off coefficient  
A= Catchments' Area in hectares contributing towards the drain  
I= Design Rainfall intensity in mm per hour  
Q= Discharge  
Runoff Coefficient shall be considered as follows;
- Concrete Paved area = 1.0
  - Bituminous Paved area = 0.9
  - Compacted but Unpaved areas = 0.7
  - Unusable/Green Belt area = 0.4

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Design of drains shall be based on Manning's formula:-

$$V = [(R^2/3) * (S^{1/2})] / n$$

V= Flow velocity in m/s

R= Hydraulic radius

S= Slope

n= Roughness Coefficient

Roughness Coefficient shall be considered as follows;

- a) Plastered surfaces = 0.013
- b) Cast in situ concrete = 0.015
- c) Concrete/Brick Lining = 0.017

18.7. The following points are to be followed while sizing the storm water drains

Minimum velocity in drains = 0.6 m/s

Maximum (Scouring) velocity in drains = 2.4 m/s

Preferred (Self cleansing) velocity in drains = 1.0 m/s

Minimum depth of drains = 300 mm



Minimum width of rectangular drains = 300 mm (for depths ≤ 500 mm)

Minimum width of rectangular drains = 500 mm (for depths ≥ 500 mm)

## 19.0 Substations buildings

These buildings house electrical switchgear and motor control centers with associated HVAC, telecoms and battery accommodation. The buildings shall provisionally be designed as per Electrical equipment layout. The screeded concrete floor shall be finished with an epoxy based hardener and sealant with corrosion resistant finishes used in battery rooms. There shall be cut-outs provided in cellar floor slab for supporting the panels. There shall be channels / insert plates all around cut-outs to support panels. In cable cellar, cable tray support shall be of structural steel fixed with mild steel base plate at bottom or top, at regular interval as per electrical requirement. The building shall be designed in accordance with OISD 173 & OISD 163.

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All doors shall be insulated metal construction with the addition of removable transformer panels for equipment access wherever required. A roller shutter door shall be provided for equipment entry to the main switchgear room.

Fire rated concrete walls shall be provided between the transformers and cable basement and the transformer compound wherever required, for the separation of the larger non-sealed type of transformers. All mesh infill panels; gates, doors, locks etc. shall be specified to meet the requirements of relevant codes and standards.

## 20.0 General Consideration

Following general consideration has been considered.

### 20.1. Circulation Spaces

Following spaces are classified as circulation spaces. These spaces shall be provided as per required building services for integrating various types of spaces and as means of access/exit/escape.



- i. Corridors & passages
- ii. Staircases
- iii. Entrance lobby
- iv. Gangway / walkways
- v. Equipment loading / unloading platforms
- vi. Emergency Exits

### 20.2. Utility Spaces

Utility spaces are space requirements, which materialize due to provision of services like air conditioning, pressurization, fire-fighting, electrical, telephone etc. Following are examples. These spaces shall be provided as per required building services.

- i. Air-conditioning plant room
- ii. Air handling rooms

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- iii. Pressurization blower plant room
- iv. Electrical distribution panels rooms
- v. Service ducts
- vi. Fire-fighting equipment room
- vii. UPS room (UPS Room for C&A will be located in Control Room)
- viii. Battery room
- ix. Control Room

### 20.3. Day Light and Natural Ventilation

Established level of illumination shall be maintained for all parts of the buildings by means of windows, skylights etc. Following references shall be adhered to in this regard.

National Building Code of India

State Factories Act

The objective of day lighting shall be as follows:

Openings shall be provided with shading devices to avoid glare. For the purpose of illumination, day lighting shall also be supplemented by artificial illumination particularly at fire exit.

### 20.4. Natural Ventilation

Established level of ventilation in terms of air changes per hour shall be maintained for all spaces. Following references shall be adhered to for the purpose.

National Building Code of India



State Factories Act

Natural ventilation shall also be supplemented by mechanical or electrical means of ventilation in all areas of habitation.

### 20.5. Safety Requirements

Safety from fire and like emergencies shall be taken into account in building / shed design. Every building / shed meant for human occupancy shall be provided with exits sufficient to permit safe escape of occupants in case of an emergency. The

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exits shall be in terms of doorway, corridors, and passageways to internal/external staircase or to areas having access to the outside.

Following references shall be adhered to in this regard. Control room building shall be provided with emergency exit on the other side of the entrance.

National Building Code of India Part IV

State Factories Act

OISD-STD/GDN-115

OISD-STD-116

OISD-STD-117

OISD-STD-173

OISD-STD-163

## **21.0 Water supply, Distribution and Drainage Sanitary Services**

This service is essential for all habitable buildings/sheds. All buildings with human occupancy shall have toilet and drinking water facility as per following references.

National Building Code of India Part IX, Section 1 & 2

State Factories Act

Drinking water provisions, including sufficient number of water cooler, minimum one per area shall be provided within an enclosure separated from the toilets. All service pipes on the external wall shall be suitably concealed.

## **22.0 Structural and Architectural Construction Requirement.**



### **22.1. Plinth Protection**

All the buildings & sheds shall be provided with minimum 1000 mm wide plinth protection around the building/shed.

### **22.2. Finished Floor Level (FFL)**

In general, FFL of the Building shall be determined with respect to top of approach road or pavement. Following schedule shall be adhered to for FFL of the building:

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Control Room Building:

Top of Approach road level + 150 mm + Height of false flooring

Electrical Sub Station Buildings:

Top of approach Road level + height of false floor minimum 300 mm (Assumed Cable Cellar floor height as 300 minimum)

Top of approach Road level +150 mm (Transformer bays) with pebbles / gravels

FGL (Finished Ground Level) + approx. 1000 mm high from top of road (in case of single storey Substation Building with trenches as per electrical equipment layout requirement.

Notes:

In case of approaches with different top levels, the highest top level of approach road / pavement shall be considered.

FFL shall be same throughout in a building.

FFL of external loading / unloading bays / platforms shall be 6-12 mm lower than that of the building's / shed's FFL to check ingress / spillage of water.

FFL shall be decided based on highest flood level experienced in last 25 years at site.

### 22.3. Steps / ramps / Staircases



Staircases shall be provided for vertical circulation & emergency exits. Number of staircases shall be based on building sizes more than 500 Sq.M ground covered area shall have two stairs (NBC-Part IV). Emergency exit requirements shall be as per safety distance requirement. At least one no. staircase / ladder shall be provided for access to the flat roof top for maintenance.

Total number of staircase shall depend on a travel distance to exit points as determined by statutory rules.

Steps/ ramps shall be provided for access to the Building for pedestrian / vehicular, equipment entry as per relevant code. Minimum 1000 mm wide platform shall be provided in between entrance door and steps/ramps. Following dimensions of the steps / ramps shall be adhered to:

- i. Stairs width - 1200 mm minimum

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- ii. Tread - 1000 mm minimum (Emergency exit)
- iii. Riser - 260 mm minimum
- iv. Slope of Ramp - 175 mm maximum & 150 mm minimum
- v. Ratio of Tread & Riser - Not steeper than 1:6 but preferred 1:10 or as Per layout requirement
- vi. No. of risers per flight - 2 Riser + Tread= 600 to 650 mm
- vii. Landing width - 12 Nos. in general
- 16 Nos. Emergency Exits
- 1000 mm minimum

#### 22.4. Walls

Following schedule shall be adhered to for wall material and thickness:

External Walls = 230 mm thick brick wall (including plaster)

Internal partition wall= 230/115 mm thick brick wall depending on the overall length and height of the wall (Refer note below)

Transformer Perfect Party / Fire resistant Walls= 350 mm (including plaster) thick brick wall or 200 mm thick RCC wall

Concrete wall = Minimum 230 thick RCC wall as per structural design

Notes:



115 mm Thick brick partition walls (with nominal steel requirement as per structure design) shall be provided with 230 mm thick brick pillars or RCC transoms / mullions for stability.

Wherever conduits or pipes are required to be concealed within partition wall, the wall thickness shall be increased suitably.

#### 22.5. Doors

Doors shall be provided for access, security and safety at all entry & exits of rooms, functional areas & the buildings. Air tight door shall be provided in pressurized area and in gaseous protection area. Fire door shall be with two hours rating as per statutory requirement.

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Emergency door shall be opened outwards. Sizes of the doors shall be determined on the basis of the following schedule:

Equipment, Panel area: Size of maximum equipment including packing.

Other areas: Volume of movement through door, W.C., Bath etc.

Cubicle Door: 800 mm x 2100mm (masonry wall opening size)

Minimum Size of other doors: 1000mm x 2100mm (masonry wall opening)

Notes:

Entrance doors shall be provided covering full width of the entrance lobby. In that case the door shall be of composite type consisting of operable shutters & fixed panels. Entrance lobby shall be provided with elaborate canopy.

Rolling shutters shall be provided wherever size of opening exceeds 2500 mm x 2500 mm.

Rolling shutters shall be provided for equipment entry for Switchgear Room/ Electrical Room, A.C. Plant Room etc.

Mechanically operated rolling shutters shall be provided for opening sizes exceeding 8 m<sup>2</sup>.

Fireproof door shall be provided as per TAC, electrical, process statutory requirements etc.


All doors except toilet door will be glazed, anodized Aluminium door with 5.5 mm thick toughened glass. For internal area plain glass shall be used.

#### 22.6. Windows / ventilators

Windows / ventilators shall be provided in all areas for natural lighting, ventilation and visibility at working level. For the purposes of ventilation, total operable area of the windows/ventilators shall be as per Factory Act subjected to a minimum of 15% of the floor area to be ventilated. However, for control room and in office areas, etc. where visibility from inside is also important, increased window area shall be provided as per OISD guide line.

Areas accommodating panels / equipment shall be normally provided with ventilators at high level for unobstructed distributed lighting. Wherever due to limitation of external wall area or any other reasons, stipulated area of window /

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ventilation cannot be provided, suitable mechanical devices shall be provided. For Workshop / Warehouse sheds etc. with pre-coated / corrugated GI roof sheeting etc. suitable monitor may added in provide additional ventilation.

Notes:

Requirement of window / ventilations area as stipulated above is for maximum room height of 4000 mm. For heights more than 4000 mm, additional window / ventilator shall be provided in the same manner at every work area / platforms at all levels.

Ventilator shall be able to serve as smoke vents in the event of fire.

Fireproof windows shall be provided as per TAC, electrical, process etc. statutory requirements.

All windows / ventilators will be glazed, anodized Aluminium window / ventilator.

All glazing on external faces of building shall be toughened glass (5 mm thick).

#### 22.7. Parapet

Parapets shall be of RCC for all buildings with minimum 300 mm high for non-approachable roof and 1000 mm high for approachable roof.



#### 22.8. Roof Gutter

Gutter with rain water pipes or R.C.C. shafts shall be provided for all the buildings / sheds with pitched roof for roof water drainage. Sizing of the gutter shall be based on area to be drained and number of outlets. Gutters shall be of RCC or sheet metal. For Workshop / Warehouse shed with Corrugated pre-coated GI roof sheeting, pre-coated GI sheets gutters may be provided. RCC shaft may be provided at the end of gutter.

#### 22.9. Emergency Exits

Emergency exits shall be provided for the building as per State Factory Rules & OISD Norms, NBC-Part IV and for individual functional spaces such as Control Room/Instrument Equipment Room, Console area, Electrical room etc. Emergency

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exits shall be located in such a manner that escape route is direct, unobstructed & without passing through any other functional areas to safe area.

22.10. False Ceiling

False ceilings shall be provided in the all air-conditioned areas for the purpose of reducing room volume and to hide air conditioned ducting etc. and also to maintain acoustic level inside any space. Also it reduces habitable room, corridor, lobby heights located in high ceiling building / shed to a reasonable & satisfactory height of 3 meter. In fire rated areas where walls & doors are required to be fire rated, false ceiling shall also have complementing fire rating. It is to be noted that false ceiling have limitations in their fire performance due to openings in them for lighting & air-conditioning. Therefore, alternative systems to prevent puncturing of ceiling must be used.



22.11. False / Cavity flooring

False / cavity flooring shall be provided to accommodate under floor cabling in Instrumentation areas like Console Room, Rack Room, Computer Room etc. Extent of false / cavity flooring shall be as per Electrical / Instrumentation requirements.

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**ANNEXURE II**  
**PIPING**

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## 1.0 GENERAL

The engineering design basis defines the minimum design criteria that shall form the basis for carrying out detailed piping design of all loading arm components and its testing.

Top and Bottom kind of loading arms assembly shall be used based on Carrier vehicle as illustrated below:

Sr. No	Loading position	Service	Carrier Vehicle
1	Top	HSD, SKO	Truck
2	Top	LPG	Rail
3	Bottom	LPG	Truck

This specification outlines the minimum requirement under which the manufacturer shall design, manufacture, test and supply the loading arm for loading / unloading operations of road tanker/ rail with top/bottom loading arrangement.



In the event of failure, the spring must be contained in a heavy duty cylinder to avoid any injury to the operator.

## 2.0 CODES AND STANDARDS

The material of construction of the pipes, flanges, valves, joints etc. shall be in accordance with relevant ASTM standards. The specification of the pipes and flanges shall be in accordance with relevant ASME, ANSI, TTMA (Tank Truck Manufacturers Association), and API standards. Wherever international standards and codes are not available, vendor may follow his own proven standards and practices subject to Client / Consultant approval.

API	American Petroleum Institute
ASTM	American Society of testing and materials
ASME	American Society of Mechanical Engineers
ANSI	American National Standards

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<b>OISD</b>	<b>Oil Industry Safety Directorate</b>
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### 3.0 TECHNICAL REQUIREMENTS

Loading Arm shall generally consist of base riser, outboard arm, inboard arm, connecting pipe or drop pipe, swivel joints, vacuum breaker, balancing arrangement, supporting arrangement and locking arrangement for filling position and parking position.

### 4.0 LOADING ARM

Each loading arm shall essentially be completed with following



- Outboard and Inboard arms
- Connecting Pipe
- Swivel Joints
- Drain and Vent Connections
- Shut Off valve
- Counter Balance Arrangement
- Supporting Arrangement
- Locking Arrangement
- Emergency release coupling with Automatic Shut off valve
- Acme coupling set

#### 4.1 INBOARD / OUTBOARD ARM & CONNECTED PIPES

The arms shall be of seamless pipes suitable for the hydrocarbon service. It shall be of seamless Carbon steel material to ASTM A106 / Aluminum pipe material to ASTM B-345 (6061/6063T3) to avoid sparking. The equivalent flange shall be 150# or 300# (based on design condition); ASME B16.5 with material as ASTM A105 / ASTM B 23 Gr.358-T6.

The arm pipe thickness shall be selected for the specified design pressure(not less than SCH40 in any case), and the bending and torsional

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stresses encountered in the loading operations.

Connected pipe / nozzle shall be provided with Acme male connector and Flange end connection. Acme coupling male and female connector shall be of cast steel and wing nut shall be of gun metal.

#### 4.2 SHUT OFF VALVE

A shut off valve shall be provided in the connecting pipe to minimize product leakage at the time of disconnection. In case of loading arms with drop pipe, this valve shall be provided in the outboard arm. The shut off valve shall be a ball valve of Fire safe type of design with full bore and should have API monogram.

#### 4.3 SWIVEL JOINT

The swivel joints shall be designed to make the arm maneuverable with the effort of a single person. The joint shall have chrome carbon steel balls in minimum two rows fixed in suitably hardened stainless steel guide ways. The seal material shall be filled PTFE with SS 316 wear and anti-extrusion rings & Inconel X-750 energizer spring.

The swivel joints bearing surface material and ball bearings material shall be suitable for fluid handled. Bearing surfaces and ball bearings shall be suitably hardened to ensure long life. The swivel joints shall be life - lubricated type.



The arrangement of swivel joint shall preferably allow changing of seal without complete dismantling bearings. The swivel joints shall have corrosion-proof sealing surfaces of stainless steel. They shall have leak detection port to enable monitoring of primary seal for possible leakage. They shall have a positive back up seal / radial O-ring to protect ball races against harsh operating condition.

Swivel joint shall be of following constructional features.

Swivel joint in base riser shall be of split flange construction, so as to allow replacement of main seals without removal of bearing balls and dismantling of swivel joint.

All other swivel joints shall be of flanged type construction or shall be provided with flanged connection on each side of these joints for ease of maintenance.

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No screwed swivel joint shall be used in the loading arm.

#### 4.4 END CONNECTION

LPG Road filling type- Inboard end shall be Carbon steel forged flanged end, whereas the Outboard end shall also be flanged end.

LPG Rail Wagon filling type- Inboard end shall be Carbon steel forged flanged end, whereas the Outboard end shall be hammer union joint.

HSD / SKO Road filling type- Inboard end shall be Carbon steel forged flanged end, whereas the Outboard end shall be Aluminium pipe open end.

#### 4.5 BALANCING ARRANGEMENT

The arms shall be counter balanced by compression spring assembly, torsion spring box with integrated locking spring, Oil-impregnated bronze bearing for carrying spring load to Eliminate ferrous-to-ferrous contact, minimizes wear, ensures smooth operation, pneumatic cylinder or hydraulic cylinder.

The balancing arrangement shall be such that the outboard arm remains horizontal in filled condition for pressure bottom loading arm and in empty condition for atmospheric loading arm.

Balancing arrangement should have five year warranty.

#### 4.6 SUPPORTING ARRANGEMENT FOR BOTTOM LOADING TYPE ARM

The arm shall be self-supported on base riser location.

The supporting arrangement shall be such that there is complete flexibility in operation.



The supporting arrangement shall be such that no load or force due to bottom loading arm is transferred to piping.

#### 4.7 SUPPORTING ARRANGEMENT FOR TOP LOADING TYPE

The arm shall be supported by column or stand post with antifriction bearing at top location.

The supporting arrangement shall be such that there is complete flexibility in

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operation.

The supporting arrangement shall be such that no load or force due to loading arm is transferred to piping.

#### 4.8 LOCKING ARRANGEMENT


Suitable locking arrangement shall be provided for locking the arm in parked position. The locking arrangement can be manual or pneumatic.

#### 4.9 EMERGENCY RELEASE COUPLING

Each loading arm shall be provided with one emergency release coupling (breakaway coupler) with self-closing valve on both the sections. It shall be of instantaneous shut down type to be installed either on terminal sleeve or on outboard arm downstream of the shut off valve. The breakaway coupler shall be of SS 316 L constructions, seals of Viton, PTFE type and shall be suitable for re-assembly in 5 minutes.



#### 4.10 GROUNDING ARRANGEMENT

Each bottom loading arm shall be electrically continuous, otherwise earthing conductors shall be provided across the non-insulating joints to make it electrically continuous. All flanged joints shall be earthed by copper jumpers.

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**ANNEXURE III**  
**ELECTRICAL**

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## 1.0 SCOPE

This document, together with other project specifications shall form the basis for developing technical bid document and detailed design engineering for all electrical facilities of the revamping of LPG rail gantry & revamping / automation of road gantry at product terminal at ONGC, Hazira plant.

The electrical work specified shall consist of equipment and materials installed in place for power distribution, system grounding, lighting etc.

## 2.0 REGULATIONS

The engineering, design and the installation shall be in accordance with the latest revision of Project Specifications and the established codes, sound engineering practices and must conform to the statutory regulations applicable in the country.



The current version of following statutory regulations shall be followed,

- Indian Electricity Act, 2003
- Indian Electricity rules, 1956
- The Petroleum rules , 1976
- Requirements of other statutory bodies e.g. CEA / State Electrical Inspectorate, OISD, CCOE, as applicable.

## 3.0 CODES AND STANDARDS

The project will be developed using standard specifications which are based on the Indian standards (IS) & International Electro technical Commission (IEC) standards, defining the minimum technical requirements for application of electrical equipment and materials in Oil Industry plants. These standards will be adapted to incorporate local requirements. Engineering design specifications and standards will be prepared to arrive to uniformity in project execution and design. These specifications will comprise mandatory design requirements for detailed design engineering.



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## NATIONAL STANDARDS



IS: 325	Three-phase Induction Motors (non-mandatory)
IS: 732	Code of practice for Electrical wiring Installation.
IS:1255	Code of Practice for Installation and Maintenance of Power Cables up to and including 33 KV Rating.
IS: 1554	PVC Insulated (Heavy Duty) Electrical Cables (parts I and II).
IS: 1646	Code of Practice for Fire Safety of Buildings (General).
IS: 1777	Industrial Luminaire with Metal Reflectors.
IS:1944	Code of Practice for Lighting of Public Thoroughfares(Part I,II)
IS:1944	Code of Practice for Lighting of Public thorough fares (part V)
IS: 2148	Electrical Apparatus for Explosive Gas Atmospheres-Flameproof Enclosure-"d".
IS: 2206	Flameproof Electrical Lighting Fittings (Part 1).
IS: 2206	Flameproof Electrical Lighting Fittings (Part 2).
IS: 2309	Code of Practice-Protection of Buildings and Allied Structures against Lightning.
IS:3034	Code of Practice for Fire safety of Industrial Buildings Electrical Generating and Distribution Stations.
IS: 3043	Code of practice for Earthing.
IS: 3646	Code of Practice for Interior Illumination (Parts I, II and III).
IS: 4012	Dust-proof Electric Lighting Fittings.
IS: 4013	Dust-tight Electric Lighting Fittings.
IS:4722	Rotating Electrical Machines (non-mandatory)
IS: 5571	Guide for Selection of Electrical Equipment for Hazardous Areas.
IS:5572	Classification of Hazardous Areas (other than Mines) having Flammable Gases and Vapours for Electrical Installations.
IS: 6381	Electrical Apparatus for Explosive Gas Atmospheres-Increased safety

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	"e"
IS: 6665	Code of Practice for Industrial Lighting.
IS:7098	Cross- linked polyethylene Insulated PVC Sheathed Cables (Parts I, II and III)
IS: 8224	Electrical Lighting Fitting for Division 2 Areas.
IS: 9334	Electric motor-operated Actuators.
IS:10028	Code of Practice for Selection, Installation and Maintenance of Transformers (parts I, II and III).
IS:12360	Voltage Bands for Electrical Installations, including Preferred Voltage and Frequency
IS: 13234	Guide for Short-circuit Calculations in Three-phase systems.
IS: 13346	General Requirements for Electrical Apparatus for Explosive Gas Atmospheres.
IS:13408	Code of practice for the Selection, Installation and Maintenance of Electrical Apparatus for Use in Potentially Explosive Atmospheres (other than mining applications or explosive processing and manufacture).
SP-30	National Electric Code – BIS Publication
OISD-STD-110	Recommended practices on static electricity
OISD-STD-113	Classification of Area for Electrical installation at Hydrocarbon and Handling facilities
OISD-STD-147	Inspection and safe practices during electrical installations
OISD-STD-149	Design Aspects for safety in Electrical Installations
OISD-STD-173	Fire Protection System for Electrical Installations
OISD-STD-180	Lightning Protection



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## INTERNATIONAL STANDARDS



API RP 500	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities.
API RP 651	Cathodic Protection of Aboveground Petroleum Storage tanks.
ANSI/EIA/TIA 329-B	Minimum Standards for Communication Antennas part I ,Base Station Antennas
ANSI/EIA/TIA 603	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
BS EN 13636	Cathodic protection of buried metallic tanks and related piping
NACE RP0169	Standard Recommended practice; Control of External Corrosion on Underground or submerged Metallic Piping System
NACE RP0186	Standard Recommended Practice - Application of Cathodic Protection for External Surfaces of Steel Well Casings.
NACE RP0193	Standard Recommended practice, External, Cathodic Protection of on-grade Metallic Storage Tank Bottom
NACE RP0290	Standard Recommended Practice; Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structure
NACE RP0388	Standard Recommended Practice; Impressed Current Cathodic Protection of Internal Submerged Surface of Steel Water Storage Tanks
NACE RP0575	Standard Recommended Practice - Internal Cathodic Protection Systems in Oil-Treating Vessels
IEC 60034	Rotating Electrical Machines
IEC 60050	International Electro technical Vocabulary
IEC 60071	Insulation Coordination
IEC 60073	Basic & Safety Principle for man-machine Interface, marking & identification-coding principle for indicators & actuators.
IEC 60076	Power Transformers
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres

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IEC 60083	Plugs and socket.
IEC 60099	Surge Arresters.
IEC 60120	Dimensions of Ball and Socket Coupling of String Insulator Units
IEC 60182	Preparation of documents used in electro-technology
IEC 60204	Safety of machinery - Electrical equipment of machines.
IEC 60227	Polyvinyl Chloride Insulated Cables of Rated Voltages up to and including 450/750 V
IEC 60309	Plugs, Socket Outlets and Couplers for Industrial purposes.
IEC 60332	Tests on Electric and Optical Fibre Cables under Fire Conditions
IEC 60364	Low Voltage Electrical Installation.
IEC 60383	Insulators for overhead lines with a nominal voltage above 1000 V. Ceramic or glass insulator units for a.c. systems - Definitions, test methods and acceptance criteria
IEC 60433	Insulators for overhead lines with a nominal voltage above 1000 V- Ceramic Insulator for AC System-Characteristic of Insulator units of Long rod type.
IEC 60439	Low-voltage Switchgear and Control Gear Assemblies
IEC 60489	Methods of Measurement for Radio Equipment used in the Mobile –Services
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 60546	Controllers with analogue signals for use in industrial-process control systems.
IEC 60549	High-voltage fuses for the external protection of shunt power capacitors
IEC 60623	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel- cadmium prismatic rechargeable single cells.
IEC 60688	Electrical measuring transducers for converting a.c. electrical quantities to analogue or digital signals
IEC 60815	Selection and dimensioning of high-voltage insulators for polluted

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	conditions.
IEC 60831	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V
IEC 60871	Shunt Capacitors for AC Power Systems having a Rated Voltage above 1 kV
IEC 60896	Stationary Lead-acid Batteries.
IEC 60931	Shunt capacitors of the non-self-healing type for AC power systems having a rated voltage up to and including 1000 V
IEC 60947	Low-voltage Switchgear and Control Gear
IEC 61000	Electromagnetic Compatibility.
IEC 61089	Round Wire Concentric Lay Overhead Electrical Stranded Conductors
IEC 61260	Electro-acoustics - Octave-band and fractional octave-band Filter.
IEC 61558	Safety of power transformers, power supplies, reactors and similar products
IEC 62271	High-voltage Switchgear and Control gear
IEC 61007	Transformers and Inductors for use in Electronics and telecommunication equipments.
IEC 61085	General considerations for Telecommunication service for Electric Power System

#### 4.0 GENERAL ELECTRICAL REQUIREMENTS

The engineering shall be based upon the following factors:

- i. Safety to personnel and equipment during operation and maintenance.
- ii. Reliability of service.
- iii. Ease of maintenance.
- iv. Provision for future expansion & modification.
- v. Convenience of operation.
- vi. Maximum standardization of equipment and materials.
- vii. Maximum interchange ability of equipment.
- viii. Minimum fire risk with adequate fire protection.

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- ix. Effective utilization of electrical energy.
- x. Suitability for applicable environmental factors.

In general all design activities shall be based on the requirements of this specification to achieve effective preparation of electrical design documents and drawings which satisfy following:

- The client.
- The authorities (if required).
- Installation contractor and construction management team.
- Accurate preparation material takeoffs.
- Design information, for other disciplines requiring electrical design information

#### **5.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION:**

All the areas within the battery limits shall be classified for the degree and the extent of hazard from flammable material. The basis for hazardous area classification recognizes the differing degrees of probability, with which flammable atmosphere may arise in installation, in terms of frequency of occurrence and the probable duration of existence on each occasion.



The area classification shall show the sources of gas explosion hazards.

The selected electrical apparatus shall be adequately protected against corrosive and solvent agencies, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

Following factors shall be considered for proper selection of electrical equipment in hazardous area.

- Area classification
- Gas Classification
- Dust classification
- Temperature Classification, The ignition temperature of the gas or vapor present in the area or the lowest value of the ignition temperature if more than one combustible material present.

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- The selected electrical equipment shall be adequately protected against corrosive atmosphere if present, water ingress or from thermal & mechanical stress.

General guidelines for type of protection for electrical equipment in hazardous areas are enumerated below in Table1.

The area classification shall be in accordance with IS: 5572 & OISD- 113. For undefined cases the IEC 60079 and/or API RP 500 shall be applied.



In the presence of combustible dust IS-15142 shall be used as a guide line for area classification & selection of electrical equipment.

The electrical equipment and installations shall be selected for suitability of use in the classified areas in accordance with IS: 5571.

It is recommended that, where reasonable practicable, electrical apparatus in general, switch and control apparatus in particular shall always be installed in safe area. All materials installed inside a hazardous area:

- Shall be certified by CIMFR/ CPRI/ ERTL or equivalent recognized independent test house such as BASEEFA/ LCIE/ PTB/ UL/ FM.
- Shall have valid statutory approvals i.e. CCOE/ DGMS as applicable for use in specified hazardous area.
- Shall have valid BIS marking and license as required by statutory authorities.

**TABLE: 1**  
**ADEQUATE TYPES OF PROTECTION**

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AREA CLASSIFICATION	DESCRIPTION	SYMBOL
Zone 0	Intrinsic safe category "ia"	ia
	Other electrical apparatus, specifically designed for zone 0	S
Zone 1	Any type of protection adequate for zone 0 (not preferred)	
	Flameproof enclosure	d
	Intrinsic safe category "ib"	ib
	Oil immersion(see note 2)	o
	Pressurization (see table 2)	P
	Sand filling	q
Zone-2	Other electrical apparatus specifically designed for zone 1	s
	Any type of protection adequate for zone 0 or zone 1 (not preferred)	
	Increased safety (see note 1)	e
	Non sparking apparatus (see note1)	n

**Notes:**

- For all outdoor installations, including the apparatus with type of protection "e" and type of protection "n", the degree of protection shall be in accordance with section 8.
- Oil-immersed apparatus may be used only in case its security will not be impaired by tilting or vibration of the apparatus.
- Selection of electrical equipment in classified area shall be as per the specification related to the area classification drawings.

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**TABLE-2**  
**MINIMUM ACTIONS ON FAILURE OF PROTECTIVE GAS FOR TYPE OF**

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**PROTECTION "P"**



AREA  CLASSIFICATION	ENCLOSURE DOES NOT  CONTAIN IGNITION  CAPABLE  APPARATUS	ENCLOSURE  CONTAINS IGNITION  CAPABLE  APPARATUS
ZONE 1	Alarm	Alarm and switch off
ZONE 2	No action required	Alarm

**6.0 POWER DISTRIBUTION PHILOSOPHY**

The philosophy will be worked out in a key single-line diagram taking into consideration the following aspects:

- i. Maximum reliability and availability.
- ii. Safety in plant operation.
- iii. Maintainability **and convenience of operation.**
- iv. Independent power supplies for process units not related to each other.
- v. Power Supply to Electrical equipment within design operating limits.
- vi. Standard distribution concepts to the maximum extent.
- vii. Possibilities for future expansions (main distribution system) (up to MCC level).
- viii. Automatic change over systems for essential and/or vital equipment/services.
- ix. Uninterrupted power supply systems for vital equipment and services.
- x. Two incomers and one bus-coupler system with 100% redundant capacity for incomers shall be considered for all Switchgears..
- xi. However Bus-coupler of 415V (Low Voltage) PCC/ PMCC shall be in "open" condition in normal operation with auto changeover facility considering sectionalized bus-bar scheme. All auto changeover schemes shall be based

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on relay logic instead of contactors.

#### 6.1 KEY SINGLE-LINE DIAGRAM

Defines the power distribution system, showing voltage at levels, fault level of the bus, bus current rating, Frequency, power supply sources, emergency distribution systems and system - earthing methods, as well as protection scheme, interlocking scheme, feeder rating and cable size and metering aspects of state electricity board. The document will be set up based on preliminary load data available at the start of the activity and the power distribution philosophy. The document will have to be reviewed and discussed with the electricity board.

#### 6.2 IDENTIFICATION OF CRITICAL LOADS

Critical loads will be determined from hazard analysis and/or safety reviews during the process design.

#### 6.3 SELECTION CRITERIA FOR PLANT DISTRIBUTION VOLTAGE LEVEL



Distribution voltages will be same as existing voltage levels followed in the plant. Same is described in section 6.6 and 6.7 in the document.

The system will be designed to arrive to the highest standard possible short circuit level as to arrive to maximum system stability under all possible operating conditions.

#### 6.4 POWER DISTRIBUTION:

- i. Main source of power supply shall be made available by extending the existing PMCC-315 located at SS-9.
- ii. 2 nos. of incomer feeder shall feed the new MCC at new control room.
- iii. 2 nos. outgoing feeder shall be provided for lighting transformer/MLDB from new MCC.
- iv. 2 nos. outgoing feeders shall be provided for lighting transformers of new high mast lights. Lighting transformers shall be Dry type, panel mounted.
- v. Required necessary nos. of motor feeder for sump pump etc. shall be provided from new MCC.

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- vi. 4 nos. (2 nos. for 110V AC and 2 nos. for 230V AC) outgoing feeder shall be provided for 2x100% redundant UPS from new MCC.
- vii. 110V AC and 230V AC, both the UPS shall be 2x100% hot redundant.
- viii. UPS shall be feeding the 110V & 230V UPS DBs.
- ix. Third incomer (stabilizer incomer for both the UPS shall be provided from S/S-3 / New MCC or the nearest source available.
- x. These UPS DBs shall be supplying the power to respective loads in the field/gantry area.
- xi. Required number of outgoing feeders for welding receptacles shall be provided from new MCC.

#### 6.5 ELECTRICAL LOADS AND ELECTRICITY CONSUMPTION:

All the components of the electrical systems must be sized for 125% of the maximum load, under the worst operating conditions. The worst operating condition is specified as that condition that can occur under normal operating conditions with limited maintenance in the electrical system, e.g. one transformer out of service in a double ended distribution system.

Generally, the worst condition for a distribution system can be calculated as follows:



- i. 100% of the normal continuous running load +
- ii. 30% of the intermittent and spare load (or the largest loads, whichever is the largest)+
- iii. 10% of the stand-by-load (or the largest loads, whichever is the largest).

#### 6.6 SYSTEM VOLTAGES, AND SYSTEM NEUTRAL FOR VARIOUS VOLTAGE LEVELS

Voltage selection is based upon economic considerations, taking the following factors into account:

- i. Size and location of loads.
- ii. Provision of future extension.
- iii. Short-circuit level.

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- iv. Availability of switchgear with suitable current rating and rupturing capacity.
- v. Possibility of keeping the number of different voltage levels to a minimum.
- For low-voltage systems (415 V and below), the neutral shall be solidly earthed.
- The system earthing at various voltage level for power distribution and utilization is as per table given below:

**TABLE-3**

DESCRIPTION	VOLTAGE	PHASES/WIRES	AC FREQUENCY/ DC	SYSTEM EARTHING METHOD
Plant utilization	415V	3Ph, 4W	50 Hz	Solid
<b><u>Electric motors:</u></b>				
Motor rated above 0.18kW up to and including 160 kW	415 V	3Ph, 3W	50 Hz	--
Motor rated below and including 0.18 kW	240 V	1Ph, 2W	50 Hz	--
Lighting, small power, etc.	415V / 240 V	3Ph, 4W & 1Ph, 2W	50 Hz	Solid
Hand lamps	24 V	1Ph, 2W	50 Hz	--
LV contactor feeders (Control & metering)	230 V (UPS)	1Ph, 2W	50 Hz	Solid
LV Circuit Breaker feeders-Closing, Trip, Protection, Auto transfer schemes	230 V (UPS)	1Ph, 2W	50 Hz	Solid
C.B. Spring Charging Motor LV Boards	240 V	1Ph, 2W	50 Hz	Solid
F&G,SG systems,	230 V (UPS)	1Ph, 2W	50 Hz	Solid
Batch Controllers	110V	1Ph, 2W	50 Hz	Solid

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system	(UPS)			
Critical lighting in Control room & substation	110 V	2W	DC	--

## 6.7 VOLTAGE AND FREQUENCY VARIATION

### AC System:

The following maximum variations in supply shall be considered for equipment:

Voltage	- Maximum / Minimum $\pm 10 \%$
Frequency	- Maximum / Minimum $\pm 3 \%$
Combined Voltage & Frequency	- Maximum / Minimum $\pm 10 \%$

Wherever required, in-plant voltage regulating equipment (tap-changer etc.) shall be provided.

### DC System:

The voltage variation to be considered for electrical control circuits shall be +10% and -15%.



## 6.8 VOLTAGE DROP:

The maximum voltage drops in various sections of electrical system at full load under steady state condition should be as below:

**TABLE-4**

SL. NO.	SYSTEM ELEMENT	MAXIMUM PERMISSIBLE VOLTAGE DROP
1	Busduct or cable between transformer secondary and HV Switchboard or PMCC	0.50%
2	Cable between PMCC and MCC or other Auxiliary switchboard	
	a. If PMCC and MCC/Auxiliary Board placed in same substation	0.50%

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	b. If MCC/Auxiliary Board placed at remote place from PMCC	2.50% ( See Note-1)
3	Cable between PMCC and motor	5%
4	Cable between MCC (Located near PMCC) and motors	5%
5	Cable between MCC (Located remote from PMCC) and motor	3%
6	DC supply circuit	5%.
7	UPS outgoing circuit	5% ( See Note-3)
8	Cable between Auxiliary Switchboard/LDB and lighting panel	1.50% (See Note-2)
9	Between lighting panel and field lighting point	4%



- xi. The maximum voltage drop at different buses during start-up of motors:
- xii. Voltage drop at the bus bar of the connected LV (PMCC/MCC) switchboard during start-up of LV motor with other normal load or during reacceleration of a group of LV motors – 10%.
- xiii. Voltage drops in cable between PMCC and MCC during LV motor start up or reacceleration which is connected with MCC – 10%. However Voltage drop on motor terminal shall not go below 15% of the motor rated voltage.

Note-1: Higher voltage drop may be permitted between PCC/PMCC and remote mounted MCC/Auxiliary switch board, if overall voltage drop up to motor (from PCC/PMCC) is limited within 5.5%.

Note-2: If it becomes difficult to achieve the specified voltage drop in cables up to lighting panel, 5% drop from Auxiliary switchboard up to lighting points may be permitted.

Note-3: Minimum voltage available across any instrument in the field shall be as per design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical design basis and instrument design basis, the latter shall govern regarding instrument power supplies.

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#### 6.9 SHORT-CIRCUIT CAPACITIES:

Each equipment shall be designed to have rupturing capacity equal to higher than the maximum value of short - circuit current calculated at the location of circuit breaker. The latter shall withstand the above maximum available fault current for one (1) second or three (3) seconds as applicable in relation to the relay Co-ordination requirements. Short-circuit duties shall include motor contribution.

#### 6.10 INSULATION LEVELS



The insulation of electrical facilities shall be in accordance with the system voltage, the system neutral earthing and the over voltages resulting in circuit due to the system fault, switching or lightning surges. The insulation coordination between the electrical equipment and the protective devices shall be done in line with IEC 60071.

Lightning arresters shall be provided wherever considered necessary.

#### 6.11 PROTECTION AND METERING SCHEMES

- i. The protective system shall be selected and coordinated so as to ensure the following:
  - a) Protection of equipment against damage which can occur due to internal or external short circuits or atmospheric discharges.
  - b) As far as possible, continuity of operation of those parts of the system, not affected by the fault. Accordingly, relays and protective devices shall be suitably selected and coordinated.
  - c) Personnel and Plant Safety
- ii. Particular care must be taken for selection of protective devices for machines and equipment operating in hazardous areas.
- iii. In general, quick-acting relays (Numerical relay with fault and event recorder with, current and voltage trends, shall be used for all the circuit breaker

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feeders) time delays (if necessary) shall be used and all fault tripping shall be done through high speed tripping relays.

- iv. Digital multifunction metering instrument with communication facility shall be provided. Networking of all such metering units board wise shall be made and the same shall be hooked up with ECS system for trending & records as and when required.

## 6.12 SPECIAL POWER SUPPLY SYSTEM

### 6.12.1 EMERGENCY POWER SUPPLY

Emergency Power Supply System will supply critical consumers in the plant in order to guarantee a safe shutdown, start-up and/or safety of the process units. Following are the critical consumers identified as a minimum requirement:

- Emergency lighting.
- UPS systems/battery chargers.
- Communication Equipment
- Fire Detection, Alarm systems and fire-fighting equipment.
- Auxiliaries of some of the critical process equipment.

The emergency supply for the above mentioned loads shall be made available from existing emergency power supply source.

Emergency power supply shall be available within a maximum time period of 30 seconds from the instant of failure of normal supply.



### 6.12.2 UNINTERRUPTED AC POWER SUPPLY:

Uninterrupted power supply shall be provided for meeting critical loads that cannot withstand a momentary interruption in voltage.

The following loads shall be connected to the UPS system:

- Instrumentation, control, HMI, PLC/DCS and safeguarding.
- Communication equipment, PA, CCTV etc. (if applicable)
- Critical safety equipment, such as fire alarm system, gas detection system, etc.

The UPS system shall have parallel redundant configuration of 230V, 50 Hz AC,

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each with 60 minutes back-up for instrumentation & DCS system and 6 hours back up for F&G/PA/Communications/CCTV systems. It shall be fed from the emergency system, wherever provided. The batteries to be used for AC / DC UPS shall be NI-Cd SMF type.

#### 6.12.3 DC POWER SUPPLY:

DC power supply system with 60 minute back up shall be provided for the Critical lighting from existing DC system.

### 7.0 EQUIPMENT DESIGN PHILOSOPHY



If not specifically mentioned, the electrical equipment shall be designed for a maximum ambient temperature of 50 degree C and an altitude not exceeding 1000 meters above mean sea level.

The environmental protection of electrical equipment to be as below indicated:

- Outdoor : IP 55 with canopy (External), IP20 (Internal)
- Indoor : LV switchgear and control gear, MCCs, DBs – IP52 (External), IP20 (Internal)
- UPS, Rectifier etc. : IP41 or IP 42

Over the above requirement, equipment located in Hazardous area shall be protected suitably as per the relevant IS/IEC.



Equipment generally to be with un-drilled gland plates.

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## 7.1 SWITCHGEAR AND CONTROL GEAR ASSEMBLIES (LOW-VOLTAGE)

- i. Switchgears that are not directly fed from transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 10% future load growth. The incomers of the switchgears shall be designed to cater to the complete load including 25% margin for future load growth.
- ii. The tie breaker rating shall not be less than the bus bar current rating, unless otherwise specified.
- iii. All Loads / motors shall have separate feeders except welding receptacles. Maximum 2 nos. Welding receptacles can be fed from a single feeder.
- iv. Maximum rating of bus-bars of 415V MCC, Auxiliary boards, lighting distribution boards should be limited to 800 Amps. Based on the current rating, 3 pole MCCB or ACB shall be used for incomer and bus-coupler and these shall have mechanical interlocks.
- v. All the PMCC/MCC modules shall be fixed type. However, ACB shall be draw-out type.
- vi. The switchboard components like circuit breakers, bus bars, bus bar supports etc shall be designed to withstand maximum specified short circuit current for a minimum time period of 1 second, unless otherwise specified.
- vii. All feeders in a LV switchboard (PCC/PMCC) having rating more than 400A shall have Air circuit breaker. MCCB shall be provided in the feeder rated up to 400A.
- viii. All MCCB Power feeders shall have earth leakage protection if feeding outdoor loads.
- ix. All panels shall have 20% or min. 1 no spare feeder of each type per panel.
- x. All indication lamps used on switchgears panels; DBs shall be of LED Cluster type.
- xi. Starter and feeder units shall be executed with MCCB and relay combinations for motors rated above 30kW; for motors rated up to 30 KW MPCB shall be used. However either case motor switching & O/L trip shall be through power contactor only.
- xii. Motor feeders shall have circuit breaker / contactor of rating at least 125% of the maximum continuous rating of the connected load.

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- xiii. The panel space heater and motor space heater shall be of 240 V AC, 1 Phase shall be separated out from the control supply for motor starter.

## 7.2 UNINTERRUPTED POWER SUPPLY (UPS) AND AC DISTRIBUTION BOARDS



- i. While sizing UPS, crest factor of the load current shall be considered.
- ii. In general a "Parallel redundant static UPS arrangement" shall be applied.
- iii. Input to the UPS system shall be 3-phase AC however Single phase output is preferred.
- iv. AC UPS control logic shall be such that the load will be fed through batteries only after failure of both the inverters. Under normal condition, the rectifier-cum-charger shall feed the inverter and charge the battery bank. If the inverters malfunction the load shall be instantaneously transferred to the bypass line through the static switch. Normally the inverter shall be operated in synchronised mode with bypass in line.
- v. UPS shall be able to cater 10% future load.
- vi. In order to achieve an instrument supply voltage within acceptable variation limits, an isolation Transformer/voltage regulator shall be applied.
- vii. AC distribution board shall be sized to cater the required AC load.
- viii. ACDB shall have at least 10% spare feeder for future use.
- ix. Boost charging facility shall be provided.

## 7.3 BATTERIES:

- i. Batteries shall be Ni-Cd SMF type.
- ii. Batteries shall be of adequate capacity to meet back up requirements as envisaged in the duty cycle as well as to take care of future 10% load growth. While sizing the Batteries, temperature correction factor, aging factor shall be considered.
- iii. Battery bank shall be sized for 60 minute back up.

## 7.4 MOTORS:

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- i. In general cage induction motors shall be applied for all services. Where limits for the application of cage induction motors are exceeded, motors of the synchronous machine type shall be applied. In general the following shall be considered for Motors;
- ii. The squirrel cage induction motors shall be designed for direct on line starting unless otherwise specified. The motors shall be totally enclosed, fan cooled type and suitable for continuous outdoor use.
- iii. The low voltage motors shall be designed for starting under specified load condition with 85% rated voltage at the terminal.
- iv. Main terminal box shall be sized as per cable size, if required TB of higher frame size shall be used.
- v. All LV motor shall be energy efficient type (EFF1).



## 7.5 CABLING, WIRING, TRAYS/TRENCHES

### 7.5.1 CABLE TYPES



LV cables will be of the following general description:

**TABLE-5**

LV cables 2.5, 4, 6,10 mm <sup>2</sup>	XLPE insulated, copper conductor, steel wire armoured / steel strip armour, PVC outer sheath, flame retardant
LV cables 16 mm <sup>2</sup> and above	XLPE insulated, aluminum conductor, steel wire/steel strip armour, PVC outer sheath, flame retardant

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- i. Cables and accessories shall be selected for the applicable voltage rating taking into account the earthing method of the system.
- ii. The cables shall be sized based on the maximum continuous load current, the voltage drop, system earthing and short circuit withstand criteria as applicable. The de-rating factor due to ambient air temperature, ground temperature, grouping, thermal resistivity of soil etc. shall be taken into account.
- iii. All cables shall follow a direct and logical route without infringing on the battery limits of unrelated plants and facilities.
- iv. All the cable routing in process area shall be above ground on top tier of the pipe rack with pre-fabricated GI cable trays. In utility areas where pipe rack is not available, it shall be built in concrete trenches with GI / MS (with epoxy paint) Trays supported in tiers. The concrete trench shall be filled with sand.
- v. The length to be indicated in the column “Length” of cable schedule shall be derived as follows:
  - Scale the length on the layout, along the center of the cable tray or trench.
  - Add approximately 5% to the measured length to compensate for deviations from the center of the tray or trench along which is measured.
  - Add the lengths for the individual run section. (e.g. inside buildings, along structures, in the switchgear, etc.)
  - Add riser heights at both ends of the cable if not covered above. (Generally a maximum length of 2 meters per riser end is sufficient if no significant risers occur.)
  - Adjust the total length found to the next higher multiple of 5 m



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- vi. For cables running over the same track to approximately the same location (e.g. a pump and its spare) the longer length within a multiple of 5m is to be listed.
- vii. All incoming cables to switchgear, UPS, DC system, Motors, DBs or any other equipment shall be sized for maximum anticipated load including 10% future load growth. Cable for capacitor banks shall be sized for 135% of the rated capacitor current.
- viii. All control cables shall have 10% spare core, except that control cables having up to seven cores may have one core as spare.

#### 7.5.2 LAYING PATTERN

- i. Cable shall be laid in one (1) layer (preferred) or in more layers. The spacing of load-carrying cables shall be in accordance with the applied de-rating factor data. Non-load carrying cables shall be joined together.
- ii. Cable trays for MV, LV & Control cables shall be separate. MV cable trays shall be kept in bottom tier, LV cable trays shall be kept above the MV tray tier and control cable trays shall be kept in the top tier. Minimum vertical distance of 300mm shall be maintained between two cable trays in plant area while 400 mm in case of substation area. Min. gap of 300mm shall be maintained between LV Electrical & Instrumentation trays. Min. gap of 600mm shall be maintained between MV Electrical & Instrumentation trays.
- iii. In plant areas, the associated control cable shall be installed in a separate tray (Preferably top tier) or min 300mm away from Electrical cables. In case of underground it shall be layed on the upper layer.
- iv. Specific attention shall be given to ensure adequate separation of cables in the vicinity of substation and at other areas of congestion.
- v. The spacing of load-carrying cables shall be in accordance with the applied derating factor data. Generally MV cables shall be laid with 1D spacing in single layer, LV cables & control cables shall be laid touching each other in (max. two) layers.
- vi. Individual cables emerging from floors of soil shall be protected against mechanical damage by means of galvanized steel pipes or rigid PVC pipes.

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Single conductor cables emerging from floor or soil shall be protected by rigid PVC pipes. These pipes shall extend at least 100 mm aboveground or floor level, and shall be suitably sealed to avoid water ingress.

- vii. Grouped cables emerging from floors or soil shall be protected collectively by a properly designed metal shield or duct in such a way that heat dissipation of the sustained load- carrying spaces to the other shall be prevented by proper sealing of openings around cables.
- viii. To avoid oil or chemicals leaking into the cable trench, the above-mentioned cable protection shall be sealed at the top around the cable(s) with a suitable sealing compound.
- ix. Cables or cable supports shall not be fixed directly or indirectly to plant equipment or process piping which may require removal or replacement.
- x. Aboveground cables shall be mechanically protected either by open conduits or by cable trays with covers.
- xi. Cables running on cable ladders shall be securely fastened with UV-resistant tie wraps.

### 7.5.3 CABLE TRENCHES

- i. The cable run between the main cable routing and the point where the cables emerge to aboveground, will either be in conduits or in small trenches, depending on the economics and practical possibilities.
- ii. The cables shall be laid in trays covered by clean sand fill, duly compacted and protected by protection tiles. The top finish over the protection tiles may be in accordance with the surrounding area.
- iii. Cable trenches in process unit if any, to be sand filled with concrete side walls and bottom & removable sealed concrete covers. No protection tiles need to be installed. Suitable drainage facilities to be provided.
- iv. Except for short length near the termination points of the cables in the plants area, underground cable pipes (ducts) shall be avoided, since relatively long pipes and ducts will affect the cable current rating unfavourably

Note: Cable that are de-rated for underground/direct burial installation do not

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require further, derating for partial installation in pipes (e.g. at road crossing) provided the piping length does not exceed 7metre. If longer runs are necessary, then the cable shall be de-rated for installation in pipes.



v. All cables shall be terminated directly in the equipment terminal box, with exception for LV cables, for which Exe/ Exd junction boxes may be installed between the underground and aboveground cables parts in one(1) of the following cases:

- To provide a smooth construction interface, i.e. avoiding long-coiled ends of underground cabling awaiting aboveground installation.
- To reduce an exceptional large cross-sectional area of that part of the cable route installed aboveground, when the underground cable is significantly derated, i.e. more severely derated than the overall rating factors given as guidance in paragraph.
- To reduce from parallel feeder cables to single cable connections on the equipment.
- To facilitate the replacement of the final cable connection to the equipment terminal box, if frequent disconnection is required or expected.
- To provide for expected settlement of the ground.

#### 7.5.4 SUPPORT STRUCTURES

- i. All electrical cable trays shall be of prefabricated hot-dip galvanized steel, ladder type with rung distance of 250mm.
- ii. Cable trays shall be installed on MS racks or supports which will be painted. It shall be joined by couplers. The distance between two supports shall be 3 meters.
- iii. The cable tray accessories, such as horizontal/vertical bends, tees, etc., shall be of hot-dip galvanized sheet.
- iv. Cable Loading shall be as per the following guidelines:

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- ✓ 150mm wide cable tray : 30kg/linear meter
- ✓ 300mm wide cable tray : 60kg/linear meter
- ✓ 600mm wide cable tray : 75kg/linear meter
- ✓ 750mm wide cable tray : 75kg/linear meter

In addition, 70kg concentrated load at centre span shall be considered.

## 7.6 EARTHING SYSTEM



7.6.1 Earthing shall meet the requirement of IS: 3043 and Indian Electricity rules. All electrical equipment shall be suitably earthed. Earthing system shall, in general cover the following:

- i. Equipment earthing for personal safety.
- ii. System neutral earthing.
- iii. Protection against Static discharges.
- iv. Separate earth system for instrumentation, DCS, ECS etc. as per specified requirements.

7.6.2 The earthing system shall have an earthing network with required number of earth electrodes connected to it. The following shall be earthed as required by the codes.



- i. System Neutral.
- ii. Current and Potential transformer secondary neutral.
- iii. Metallic non-current carrying parts of all electrical apparatus such as transformers, earthing resistor, switchgear, motors, lighting/ power panels, terminal boxes, control stations, lighting fixtures, receptacles etc.
- iv. Steel structure, loading platform etc.
- v. Cable trays and racks, lighting poles.
- vi. Cable shields and armour.
- vii. Flexible earth provision for wagon, truck.
- viii. The earthing systems shall be arranged to permit periodic testing of earth resistance from earth connection at major equipment. All frames of equipment shall be earthed by two (2) earthing terminals with two (2) connections to the grid.

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- ix. Electrical system and equipment. A value that ensures the operation of the protective device in the electrical circuit and not in excess of 1 Ohm.
- x. Static electricity 10 Ohm.
- xi. The earthing system shall consist of earthing electrodes, a number of earthing loops or grids and connections to all equipment requiring earthing.
- xii. For earthing of remotely located (where no earth loop or grid is available) motor up to and including 55 kW and other 415 V and 240 V electrical equipment, a green/yellow colored insulated earthing conductor shall be included in the multi conductor feeder cable.
- xiii. Connections to main earth grid underground, all joints and taps in underground cables, connections to the steel or iron bases of non-removable equipment to be earthed shall be by "cold weld or thermo weld" welding process. Normal welding procedures with bitumastic treatment are acceptable.
- xiv. Earthing connections to motor frames and housing of equipment which may have to be removed during maintenance shall be made by soldered cable using metric screws for fastening to the housing or by other suitable means.
- xv. The methods of earthing equipment and devices for computers and for instrumentation shall comply with the specific earthing requirements for the particular equipment. In general, a separate earthing system is required and no other equipment shall be connected to it.
- xvi. Buildings shall be protected against lightning in accordance with Indian standard code of practice for the protection of buildings and allied structures against lightning: IS: 2309.
- xvii. Where an electronic Earth Providing Unit (EPU) is specified for loading or unloading facilities, the system shall prevent the electrically-driven pump unit from starting if the specified earth loop resistance value is not achieved. Both local and remote alarm facilities shall be provided.
- xviii. Inside hazardous areas, all in-line instruments and valves that are clamped between non-conductive packing shall be bonded with a conductor. For this purpose adequate lugs shall be provided on both the instrument (valve) and the pipeline.

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xix. Final connections to equipment and earth bus bar shall be with the aluminum cable in accordance with Table-6.

**TABLE-6**

<b>BARE GI STRIP / ALUMINIUM CABLE</b>	<b>APPLICATION</b>
16mm <sup>2</sup> Single Core Aluminium Cable, PVC insulated	Motors up to 18.5 KW, Small equipment and instruments, Push-button stations, Street lighting poles, Cable tray Inter, links, Junction Box, Single phase Sockets.
35mm <sup>2</sup> Single Core Aluminium Cable, PVC insulated	Motors up to 37 KW, Welding receptacles, High mast poles, Local Panels (MLDB, LDB, PDB and Instruments), IRC/IFC Panels.
70mm <sup>2</sup> Single Core Aluminium Cable, PVC insulated	Motors up to 75 KW,
185mm <sup>2</sup> Single Core Aluminium Cable, PVC insulated	Motors up to 160 KW.
40 x 5 strip	Building columns, Storage tanks (vertical and horizontal), Pipe racks, Heat exchangers and Loading racks.
75X10 mm GI strip	LV switchgears, power transformer, earth grid around sub-station, Main grid process units.
50X 6 mm GI strip	Rectifier, Lighting Transformer, UPS, MCC room, etc.

xx. The armour of power cables shall be used for earthing continuity in combination with the earthing grid, i.e. Connected to the distribution panels earth bar and in motors to the earth bolt inside the main connection box. This earthing connection is additional to the normal safety earthing connections.

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xxi. Lightning protection shall when required, follow the requirements of IS: 2309.

OISD-STD-180 may also be referred for details on lightning protection.

xxii. Metal parts of the cable racks and trays shall be bonded and connected to the common earthing grid at every 25 meter intervals.



xxiii. Lighting fixtures and convenience outlets may be earthed via an earthing lead of the supply cable. The earthing lead shall have a minimum cross section in accordance with IS: 3043.

xxiv. Static Electricity : Adequate provisions wherever necessary for control of static electricity shall be made in accordance with ID : 7689.

## 7.7 LIGHTING SYSTEM

7.7.1 Plant lighting system shall comprise of,

- Normal Lighting
- Emergency Lighting
- Critical Lighting

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7.7.2 Normal and emergency lighting shall be fed by AC supply (415V/240V), three phase four wire while critical lighting shall be fed from 110VDC system.

7.7.3 There shall be two types of lighting Normal and Critical lighting. Critical lighting to be installed in Gantry also in addition to Control room / Substation as per OISD 149. Normal lighting system shall provide enough illumination so as to enable plant operators to move safely within accessible areas of plant to perform routine operations. The normal lighting shall be approximately 85% of the total lighting installation supply from the normal AC Lighting distribution. The emergency lighting shall be approximately 15% of the total lighting Installation supply from AC emergency lighting distribution. In addition to the normal and emergency lighting installation, critical lighting (escape lighting) to be installed inside substation and control room or any permanent building inside operational areas. Required number of fixtures shall be installed at strategic places for safe movement of personnel and be supplied from 110 V DC lighting distribution.



For lighting, transformer shall be installed along with energy meter at the feeding source.

7.7.4 Areas for emergency lighting shall include, but not limited to, the following.

- All areas requiring critical lighting.
- Strategic locations in process, utility areas where specific safety/shut down operations to be carried out.



7.7.5 Areas requiring critical lighting shall include, but not limited to the following:

- Control room
- Substation

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- 7.7.6 During normal operation, both normal and emergency lighting shall be fed by normal power source. When the normal power supply fails then emergency lighting loads shall be transferred to emergency power supply after availability of emergency power supply source. The DC lighting shall be ON when AC power supply fails and it shall be fed by the battery bank.
- 7.7.7 For (indoor) safe areas, in general fluorescent-type lighting fixtures shall be applied with electronic ballast, either pole or ceiling mounted. On platforms poles with 1 x 28 W fixtures shall be used.
- 7.7.8 In control rooms LED type lighting fixtures shall be installed as per OISD.
- 7.7.9 T5 fixtures shall be used to the maximum extent, fixed to steel work. For lighting in hazardous areas Mercury vapour lighting fixtures/lamp shall be applied. As much as possible floodlighting shall be applied. For the type of lighting fixture in different location see Table 7 and note 3.
- 7.7.10 Lighting fixtures in operating area shall be mounted at least 2.5m above floor level. Platform lighting shall be installed such that operators are not blinded and bordered by their own shades.
- 7.7.11 Adjacent fixture shall be connected to different feeder circuits, or phases.
- 7.7.12 DC Critical lighting shall be provided, applying incandescent lamp in permanent enclosed structure within the plant area like substation, Control room etc.
- 7.7.13 Refer table-4 for the maximum allowable voltage drop in the lighting circuits.
- 7.7.14 The lighting fitting in zone 2 areas shall be in accordance with IS: 8224 / 5572.
- 7.7.15 All lighting fitting for outdoor use shall be weatherproof (IP 55W) as a minimum and, where located in hazardous area shall be certified for use in the appropriate classified area and gas group in accordance with the relevant Indian standards.

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7.7.16 The Lighting system shall be designed to provide a sustained and uniform illumination level of not less than the values given in Table 7, taking into consideration a maintenance factor of 0.6 for outdoor and 0.8 for indoor lighting system.

**Table-7**

<b>LOCATION DESCRIPTION</b>	<b>AVERAGE INTENSITY LUX</b>
Main control room <sup>1</sup>	400
Other control rooms/panels <sup>1</sup>	300
Office areas <sup>1</sup>	300 <sup>2</sup>
Stair	50
Corridor	70
Switchgear rooms	150 - 200
Battery room	150
UPS /Charger room	300
Cable cellar/room	100
Toilets and locker rooms	100
Ladder/stairs/operating platforms	20 ~50
Process areas	60
Street lighting	10
Working area in remainder plant areas	100

- NOTE:
1. Measured 1 m above floor level. (For walkway/staircase, work plane height is considered at floor level)
  2. Minimum illumination level - Specific areas and operating / work spots to have an adequate higher level.
- The color designation of fluorescent lamps shall be 84.

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7.7.17 High Mast shall be installed for general illumination of outdoor areas, wherever practicable and shall conform to in design features to the areas, where located.

7.7.18 In control room, etc., with computer terminals installed, attention shall be given to glaring.

7.7.19 If necessary, aircraft warning obstruction lighting (LED type) shall conform to the requirements of Annex-14 of the International Civil Airways Organization (ICAO) and National Airport Authority of India.

7.7.20 Socket outlet combinations in process areas shall be spaced to allow 50 m extension cables to reach all areas and shall be 1x24V AC, 16 A via built in transformer with integral switch for hand lamp. The source of these socket outlets shall be through 300mA ELCB.

7.7.21 In hazardous areas (zone 1 and zone 2), socket outlet combination shall be suitable for the area classification. In other outdoor locations the same socket combination shall be applied for uniformity. The source of these socket outlets shall be through 300mA ELCB.


7.7.22 Area plant lighting and street lighting will be controlled by Astro time switch (Which works based on sunset and sun rise time of a particular date). Provision for switching off all outdoor lights from single location shall be kept in lighting DB.

7.7.23 Miniature and moulded case circuit breakers shall be specified throughout and shall be either double or 4-pole switching. The plant outdoor lighting shall be automatically switched by a heavy duty contactor integral with the main lighting switchboard and controlled by an Automatic timer tracking sunrise and sunset / black- out system with a manual override facility.

7.7.24 Lighting inside building shall be individually/group controlled by switches or directly from lighting panel.

7.7.25 Initial circuit loading shall not exceed 80% of rating of the protective device.

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7.7.26 Selection of circuits shall take the inrush currents under the worst condition into account.



7.7.27 The lighting system shall have the facility to switch off (black out) the complete outdoor lighting from a central point in the control room.

7.7.28 Lighting transformer (dry, isolation type) will be applied for the lighting systems. The secondary Voltage will be 400V with +/- 5% taps in steps of +/- 2.5%. The primary voltage will be 415 V.

7.7.29 Lighting load on each circuit shall, in general be limited to 1.8 KW at a power factor of 0.8.

7.7.30 Battery room shall have fixtures mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room.

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## 7.8 CONVENIENCE RECEPTACLES

- 7.8.1 Welding receptacles with adequate number shall be provided at suitable locations to ensure accessibility with a 50 m length of cable to any point in the process area. The welding receptacles shall be rated for 63A, 415V and suitable for 3 phase/4 wire system.
- 7.8.2 Three pin socket shall be provided at suitable locations for lamps and portable tools to ensure accessibility with a 15 m length of cable to all manholes of process equipment and other important areas in the process plant. The three pin sockets shall be rated for 15 Amp, 240V single phase with earth connection. In hazardous area, 240/24V transformer with three pin socket shall be provided for hand lamp connection.
- 7.8.3 All safe area receptacles shall be of non-corrosive enclosure made out of Aluminium / FRP. All hazardous area receptacle enclosure be tested by CMRI and certified by PESO.



## 7.9 MOTOR OPERATED VALVE

MOVs shall be provided with integral starters. The local/remote selector switch, torque limit switch, start/stop control switches shall be mounted on the actuator for local/remote operation as per the mode of selection. The mechanical design shall be adequate to trip the motor without damage in case the torque limit switch fails. The control circuit will be AC operated for short distance and DC operated for extended distance.

## 8.0 SUBSTATION DESIGN PHYLOSOPHY:

- 8.1 The substation shall be located in a safe area close to the load centre. Consideration shall be given to cooling tower sprays, vapours, and conductive dusts, contributing to the insulation breakdown, vehicle traffic or any other factor that might affect the operation of the substation.
- 8.2 The main substation floor, for large plant, shall be suitably raised above grade level and the area below the substation floor shall be utilized as cable cellar for installation of cable trays. The switchgear rooms shall be provided with air curtain

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at the entrance to prevent ingress of dust. The building shall be sized to take care of present/future needs and adequate clearance given between equipment for ease of maintenance. The “ I “ beam shall be provided for lifting panels into floor.

- 8.3 The cable cellar floor shall be at least 300mm above approach road level and shall be paved and cemented. The cable cellar shall have a minimum height of 2.5 m. Transformer floor shall be at least 150 mm above the approach road level. Cellar too will have fire detection system
- 8.4 A separate entry of minimum 3 m x 3 m with rolling shutter shall be provided for drawing in all equipment for erection. Substation shall have emergency door opening outwards. Two separate entry / exit form each floor shall be provided.
- 8.5 Substation shall be without any columns within the switchgear room for optimum utilization of substation space.
- 8.6 Substation will be provided with Air handling unit along with cooling facility.
- 8.7 Fire proof doors shall be provided in all substations rated at least for 30 minutes.
- 8.8 Equipment, like UPS and other power electronics equipment may be installed in a separate air-conditioned room to avoid undue temperature rise, if required. Same to be decided during detail engineering.
- 8.9 Space for future extension of switchboards shall be provided in all substations. One panel extension space on each side i. e. for each bus section or two panel extension space in one side (in exceptional cases) shall be provided for all PCCs, MCCs and Auxiliary boards. In addition, space for future extension of the Substation building shall be considered.
- 8.10 The substation building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various equipment shall be maintained:

**TABLE-8**

SL.NO.	LOCATION	CLEARANCE
1	Front clearance for all other switchboards (Draw-out PMCC/MCC etc.)	2000 mm

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2	Rear clearance for panels having maintenance access from front only.	Less than 200 mm or more that 750 mm
3	Rear clearance for panels having maintenance requirement from rear.	1500 mm (for HV/ LV switchboards)
4	Side clearance between two switchboards or nearest obstruction	1000 mm after considering space for future panels.
5	Front clearance for wall mounted equipment	1000 mm
6	Front clearance for operation station/ control panel	2500 mm

Vertical clearance above top of the highest equipment shall be minimum 1500 mm measured from roof slab (except transformer bay where same shall be 1000 mm) and minimum 500 mm measured from the bottom of the lowest roof beam. However for the areas with false ceiling, minimum clearance of 750 mm shall be provided between false ceiling and top of any equipment.



- 8.11 Common alarm facilities shall be provided in the control room (i.e. HVAC- failure common electrical alarm and common electrical failure/trip). An annunciation panel, monitoring the switchgear and associated equipment shall be installed (if required) in the substation Adequate ventilation shall be provided in the substation as well as in the cable cellar. All HVAC/ Substation pressurizing system shall be provided with Gas Leakage Detector system to shut-off the air intake on detection.
- 8.12 Fire protection for switchgear room shall be provided to comply with requirements of OISD-STD-173.
- 8.13 All electrical substations shall have provision of rooms for
- Maintenance room
  - Toilet in ground floor

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**ANNEXURE-IV**  
**INSTRUMENTATION AND CONTROL**

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## 1.0 GENERAL

This document together with other project specification shall form the basis for developing technical bid document and detail engineering for all Instrumentation and Control facilities for revamping of LPG rail gantry and revamping / automation of road gantry at product terminal at ONGC Hazira plant.

- 1.1 All instrument and equipment shall be suitable for use for specified site climatic conditions and industrial environment in which corrosive gases and / or chemicals may be present. As a minimum, all instrument and enclosure in field shall be dust proof and weatherproof to IP-65 as per IEC-60529/IS-13947 or equivalent NEMA enclosure rating or better and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.
- 1.2 The design of electronic instrument shall be in compliance with the electromagnetic compatibility requirement as per IEC 61000-4, electromagnetic compatibility for industrial process measurement and control equipment.
- 1.3 All instruments shall be intrinsically safe. Selection of instruments shall be based on area classification of hazardous areas and shall be selected based on entity parameters. Flame proof requirements shall be fulfilled based on application.
- 1.4 Instruments shall be certified by CCE India. Indigenous equipments shall comply with BIS requirement.
- 1.5 Material of construction and end connection rating shall be as per piping material specification as a minimum. However for inline instruments it shall be of minimum #300 rating.
- 1.6 Threaded end connection shall be to NPT as per ANSI B1.20.1. Flanged end connections shall be as per ANSIB16.5.
- 1.7 Solenoid valves used in hazardous area shall be flameproof type (110VAC). Solenoid valve body material shall be SS316.
- 1.8 Prefabricated FRP canopy shall be used for field instruments and junction boxes.
- 1.9 For instrument electrical interface, input and output contacts shall be in separate multicore cables.

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- 1.10 All instruments in sour service shall meet NACE requirement.
- 1.11 Diaphragm seal instruments with capillary shall be used for congealing & viscous services. In all liquid lines having heat tracing and where suitable material is not available in corrosive services, in this case the flange material shall be in accordance with piping class. Spacer ring shall be provided with flushing connection. MOC of capillary shall be min. SS316 with SS304 armouring.
- 1.12 All junction box / local control panel shall be fire proof with Allen screws type fasteners with self-locking type. All cable entry to junction box / panel shall be from bottom.
- 1.13 Clamp type terminals shall be used.
- 1.14 Double compression type cable glands suitable for multipair and single pair shall be used.
- 1.15 Cable glands for explosion proof type junction boxes shall be explosion proof.

## 2.0 DEFINITION



T/C	THERMOCOUPLE
T/W	TEST THERMOWELL
IP	INGRESS PROTECTION
NPT	NATIONAL PIPE THREAD
RTD	RESISTANCE TEMPERATURE DETECTOR
LRC	LOAD RACK COMPUTER
CCE	CHIEF CONTROLLER OF EXPLOSIVES
FCI	FLUID CONTROL INSTITUTE

## 3.0 CODES AND STANDARDS

Design and terminology shall comply, as minimum, with the latest edition prior to the date of purchaser's enquiry with the following codes, standard practices and publications.



SR. NO.	CODE / STANDARD	DESCRIPTION
1.	AMSE B16.5 ASME SEC VIII	Steel Pipe flanges and flanged fittings Boiler & pressure vessel code rules.

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SR. NO.	CODE / STANDARD	DESCRIPTION
2.	ANSI/ISA 575-01	Control valve sizing , capacity test procedures, face to face dimensions, leakage
3.	RP 520	Fire sizing of safety and control valve
4.	RP 598	Control valve leakage
5.	OIML standard R 117	(Measuring systems for liquids other than water)
6.	ISO 4185	Standard for measurement of liquid flow in closed conduit- weighing method
7.	ISA RP SS-1 S 62-01, S82-02 S8-03, S18.1	Instrument Society of America standard and codes
8.	IEC 61131 PARTS 1-4	Programmable controller
9.	DIN V VDE 0801	Principles for computers in safety related systems
10.	DIN V 19250-1994	Safety consideration for fail safe control for control and instrumentation equipment
11.	IEC 61508	Functional safety programmable electronic system
12.	IEC 1131-3	Engineering software for development and configuration
13.	IEEE 802.3, IEC, CSA	International Standards
14.	IEC 801/EN 50081/82	Electromagnetic compatibility
15.	IEC 79.10/BS 4683	Hazardous area classification
16.	IEC-529 / NEMA / IS 2147 / IS 13947:1992	For execution of Instrument Enclosures
17.	NFPA 70	National electric code for firefighting system
18.	OSID recommendations	For storage, handling and safety systems and

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SR. NO.	CODE / STANDARD	DESCRIPTION
		transportation
19.	CENELEC EN 50014-50039	European norms for Hazardous area equipment and accessories
20.	EN 60950-1992	Power supply
21.	ANSI MC 96.1	Thermocouples
22.	DIN 43760	Resistance temperature detectors
23.	IS 3624	Specification for pressure and vacuum gauges
24.	IS 1554/ IS 5831	PVC insulated cables
25.	TIA/EIA 568A - ISO / IEC 11801	Telecommunication cable standard
26.	ASTM 1086	Tank instrument system
27.	API MP MS 3-1A	Standard practice for manual gauging of Petroleum and Petroleum product in stationary tank
28.	API MP MS 3-1B	Standard practice for level measurement of liquid hydro carbon in stationary tank for automatic tank gauging
29.	API MP MS 7-4	Static temperature determination using fixed automatic tank thermometer
30.	ISO/TC28/Section 3	Terms relating to calculation of oil quantity
31.	ISO 4266	Petroleum and liquid petroleum products – Measurement of level and temperature in storage tanks by automatic methods.
32.	OIML R85	Automatic level gauges for measuring the level of liquid in fixed storage tanks.
33.	IS 2801	PD meter Accuracy
34.	SIGTTO	Society of International Gas tanker and

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SR. NO.	CODE / STANDARD	DESCRIPTION
		terminal operators
35.	BASEEFA / PTB / KEMA/ FM / ATEX / TUV / CCE / CMRS / ERTL / CPRI / IBR / RDSO / W&M	Statutory standards
36.	BS 5308 Part-I	Instrumentation Cable
37.	ISA –S5.1	Instrument Symbol & Identification
38.	ISA- S 5.2	Graphical symbol for Process Operators
39.	ISA 5.3	Graphical symbol for LRCS / Share Display instrumentation logic & computer system.
40.	IS 2148	Flame proof , enclosure for electrical apparatus
41.	IS 3624	Specification for Pressure & Vacuum Gauges



#### 4.0 Design Criteria / Requirement – Specific Application

##### 4.1 Temperature Instrument

##### 4.1.1 Thermowell

- I.D. of Thermowell shall be 7.5 mm to 8 mm to suit T/C, RTD.
- I.D. of test Thermowell shall be 10 mm to 12 mm.
- Special thermowell design for exotic material like Inconel / Monel and also thermowell for high pressure applications shall be considered case to case basis. Flange type thermowell shall be considered up to 600 psi ratings.
- Welded type T/W shall be considered as required.
- Wake frequency calculations for Thermo well are to be done. Wake frequency shall not be exceeding 80% of natural frequency. Thermo well shall suitable for stresses due to stream velocity condition. Minimum ratio of natural frequency to Von Karman trail shall be 1.5 in ambient water up to fluid velocity. Vibration analysis shall be carried out.

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- All temperature sensing devices shall be installed in protecting thermowells. The thermowell material shall be minimum 316SS for temperature up to 600°C and Inconel above it.
- Thermowell shall be flanged type according to equipment and pipe specifications. The flange size shall be 40 mm (1.1/2 inch) with rating and facing according to the line classification.
- Thermowell in high velocity service mounted on pipeline shall be assessed for vibration resonance effect as per ASME PTC 19.3



#### 4.1.2 Temperature elements

- The preferred method of temperature measurement for temperature up to 600°C is by Resistance Thermometer Detectors (RTD's) Resistance thermometers shall be duplex 3-wire type, Platinum 100 ohm at 0 °C complying with IEC-751.
- Temperature measurement greater than 600 °C shall be made using Nickel-Chrome / Nickel-Aluminum, type K thermocouples. Cryogenic temperature measurements shall be made using Copper-Copper / Nickel / Aluminum, type T thermocouples.
- Thermocouple shall be supplied in accordance with IEC-60584-2. Appropriate extension and compensating cable shall be used.
- Thermistor elements are not permitted except for motor winding thermal protection.
- Temperature elements shall be supplied complete with thermowell, extension, head and integrally mounted transmitter as a complete assembly.

#### 4.2 Pressure transmitters

- Pressure transmitters shall be referenced to atmospheric pressure.
- Transmitters should be smart type with HART protocol, with independent adjustment of zero and span at the instrument. Accuracy shall be +/-0.075% of the calibrated span.

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- Materials of construction shall be suitable for the process media and based upon the piping specification. In general pressure transmitters should have carbon steel bodies and 316L stainless steel diaphragms as a minimum. For corrosive service suitable materials and chemical seals shall be selected.
- Scales shall be selected to cover the range requirements for both start-up, normal and design conditions of plant operation.
- 2-valve manifolds (SS316) shall be used for secondary isolation, venting and calibration of pressure instruments.

#### 4.3 Level Transmitters

- Float and Tape/Board type or Guided wave radar type Instrument shall be used for sump level.

#### 4.4 Flow Instrument



- The Coriolis Mass Flow meter shall be capable of handle minimum and maximum flow. Maintaining accuracies within limit. The flow meter shall give the pulse output to the batch controller which is in turn decide the net weight of Product to be filled in the tanker / wagon and accordingly operate and adjust the loading control valve. Necessary pulse transmission to batch controller shall be incorporated as desired.
- Custody Meter shall be used for road gantry.
- Accuracy shall be 0.1% or better.

#### 4.5 Proving Facility

- The Flow metering system accuracy can be checked online using the online proving system provided with the Master Mass flow meters and the BCU 's periodically (BCU shall be termed as FCU also and both refer the same device). The static prover tanks (2 KL and 5 KL) shall be used to cross check the accuracy of mass flow meter.

#### 4.6 Earthing Relay

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- An earthing relay with earthing clamp and flexible cable shall also be provided to ensure proper earthing of the tanker and to initiate stoppage of loading operation in case of earthing failure. This is also to be hooked up to the batch controller for start / stop interlocking for tanker earthing.
- There is a single earthing relay per bay irrespective number of BCUs in a bay. This is due to the fact that only a single truck can be positioned in the bay for loading of multi products/ single product.
- It shall be with FM approval.

#### **4.7 Batch Controller**

4.7.1 Prime design considerations for Batch controller & touch key are

- Dual channel type which can control two products
- Distributed Batch control operation in tandem with LRC.
- Automatic truck identification through rugged & intrinsically safe integrated Access control device.
- RIT with pushbuttons & lamps for operator interaction at the filling point without language barrier.
- Meet batch accuracy requirements of +/- 0.1%.
- Facilitate stand-alone operation in case of link failure with LRC.
- Facilitate operator interaction facility through built-in key-board and display
- Data storage facility for previous 200 transactions.
- Earthing Relay & Loading Arm Position Switch Interlock for all products.



4.7.2 The following loading related information would be displayed on the FCU:

- Product Name
- Compartment No / Truck No.
- Volume count up
- Error/Alarm/Operator Messages
- Pre-set Quantity

4.7.3 Functional Capability

- Batch Control through weight basis with slow opening and slow closing of loading control valve.

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- b). Earthing logic failure interlock.
- c). Local start / stop at batch controller level.
- d). Emergency stop from control room.
- e). Temperature & Pressure compensation.
- f). Volume Correction to API Tables (15 or 20 Deg. C)
- g). Self diagnostic.
- h). Configuration capability to define percentage of batch weight for initial low flow start etc.
- i). Cumulative flow counting provision.
- j). Flow Limiting.
- k). Shut Off whiles any breakage.
- l). Interfacing with TAS

#### 4.7.4 Inputs :

Digital input minimum 10 nos. for interfacing with earth interlock, 2 nos. of ESD PB, 1 no. for control valve etc. Minimum 6 nos. of inputs of two pulse input & 4-20 mA from Coriolis Mass Flow Meter / Loading arm position switch and over spill protection and analog inputs for PT and TE.

#### 4.7.5 Output:

Two Digital output for control valve etc. as well as potential free contacts for user defined functions. RS485 digital serial interface communication link (min. 2 nos.) for future interfacing with weighing system. All inputs /outputs shall be galvanically / optically isolated). Signals from earthing interlock, RTD with necessary linearization shall be included in the Batch controller unit.



#### 4.7.6 Control Mode

Local mode; Preset batch weight and other data inputs / computation activities and also auto mode facility to be provided for connected with TAS.

### 4.8 Remote Interaction Terminal (RIT):

RIT is devise used for interaction between the bay operator and the LRCS. In addition to the regular feedback from the operator for loading operation like Ready for Loading, Start Loading, Alarm Condition etc, RIT shall have

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Emergency shutdown switch for the bay i.e to stop loading at particular bay only in case of any emergency.

#### 4.9 Proximity Card Reader:

Proximity card Readers and Proximity Cards shall be of Robust Design, Dirt, Oil or rough handling shall not affect its performance. They shall preferably be RF based. Card Reader shall be considered for Road Gantry only.



#### 4.10 Barrier gate:

- The Barrier gate is provided in the Entry and exit gates of the each gantry with the Auto and Manual operation. The Gate will be controlled by the Access Control system in Auto Mode.
- The Access Control system will give the open command to the barrier gate to open. The barrier gate will be automatically closed using the infrared Sensor once the truck passes through the gate. During Emergency condition the gate will be kept open till the emergency is reset.
- All the licensed area entries are restricted for usage and the entry to these areas are restricted and controlled using the following plant access control Sub-System.
  - ACDs
  - Entry Barrier gates
  - Exit Barrier gates
- Display Boards

#### 4.11 Display Unit

- Four display units one each for ATF / SKO / HSD and LPG trucks are installed in the respective parking area. These display units displays the truck number and bay number allocated to the truck.
- The units have 2 lines of scrolling display and an automatic announcement system.

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#### 4.12 Intrinsic Safety Barriers

All hazardous area signals are routed through dual channel IS barriers which are installed in PLC I/O cum marshaling cabinets.

### 5.0 SECURITY GUIDELINES FOR TERMINAL AUTOMATION SYSTEM (TAS):

5.1 Following security guidelines for a secure operation of the Terminal automation system shall become a part of the system.

- The automated terminal control room operations shall be manned only by ONGC staff / officer and shall not be manned by the vendor representative.
- Batch controller shall keep the operational data for the day and the same shall be compared with the LRCS database for generating exception reports.
- The automation vendor has to provide security for the total operations with a view to have an audit trail of each and every operation at the automated location.

5.2 The security and authorizations shall be implemented at the following areas:

#### 5.2.1 Operating system:

Each and every user shall be provided a User-ID with proper authorizations for logging into the operating system.

“Administrator” User-ID shall be only be used for installation of software and any maintenance purposes. It shall not be used for day-to-day operations.



Users shall not be allowed to login to the system with “Administrator” user for day-to-day operation.

Administrator User-ID and other user-IDs and passwords shall be allowed shall be changed. It shall not be hard coded in the software.

#### 5.2.2 Database:

Users shall not be allowed to open and update the database directly.

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Only the Administrator shall be allowed for any maintenance work to make changes to the database and all the changes made to the database shall be logged.

Database shall be allowed to be updated only through the application with proper authorizations and shall not be allowed shall be updated directly.

Security and authorizations shall be implemented on a role based authorization system. Referential integrity checks shall be built into the database to maintain the integrity of the database.

For all completed physical operations, the data recorded in the database shall not be allowed shall be updated / changed.

### 5.2.3 **Application software:**

Security and authorizations shall be implemented on a role based authorization system. Application software shall provide creation of various User Group with specific authorizations for the Group. Different User Group like Manager, Supervisor, Engineer, Operator etc. shall be created and define Menu/ Screens and Add/ update / modify restriction for each group. Application software shall provide creation and maintenance of User IDs and attaching the various roles defined above to each and every individual at the location.

It shall provide exceptions report consisting of changes / cancellations and manual creation of data at the end of the day.


Report shall be provided listing the trucks filled from the TAS / LRCS database and also the same from the Batch controller information from the bays. The same has shall be reconciled at the end of the day operations.

Automation Vendor shall also provide reputed antivirus solution (latest) for the servers being provided based on the type of the operating system used. Antivirus update shall also be carried out every month during the warranty period.

### 5.3 **Basic Design Parameter For TAS**



i.	Type	Microprocessor based 32 bit
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ii.	Distribution	Functionally distributed for processors and I/O modules
iii.	Performance	<ul style="list-style-type: none"> <li>a. Execution time of command from CRT / keyboard to the field equipment through output card will be less than 1 second.</li> <li>b. Updating of display and parameters on the screen will be max. 1 second (for page with 100 live points)</li> <li>c. Time for display on VDU screen on operator's request will be max 1 second.</li> <li>d. Scanning rate of the critical loop will be 100 milli seconds</li> <li>e. Scanning rate of Analog inputs will be max 200-250 milli seconds.</li> <li>f. Scanning rate for Digital inputs will be max. 100 msec.</li> <li>g. Scanning rate for Pulse Signals will be max. 100 milli seconds.</li> <li>h. Updating rate of Pulse Signal will be max. 1 second.</li> <li>i. Closed loop control update time of 250 milli seconds.</li> <li>j. Open loop control update time will be 100 milli seconds for all loops.</li> <li>k. Minimum trending scan rate - 200 milli seconds (selectable between 200 milli seconds and 10 seconds).</li> <li>l. Minimum trend display time - 1 Second.</li> <li>m. The TAS shall be interfaced to existing SAP system of Hazira Plant</li> </ul>
iv.	Sensor	a. Field interrogation Voltage is +24 V DC.



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		b. Output of analog transmitters will be 4-20 mA DC.
v.	I/O modules	a. Galvanic isolation for Analog input and output, Optical isolation for Digital input and output will be considered. b. As per process area classification, suitable safety active barriers will be envisaged. c. The channel density for various types of cards will be as follows: <ul style="list-style-type: none"> <li>I. Analog input cards (including RTD and thermocouple). 16 channels max.</li> <li>II. Analog output cards: 16 channels max.</li> <li>III. Digital input cards: 32 channels max.</li> <li>IV. Digital output cards: 32 channels max.</li> <li>V. Thermocouple cards: 16 channels max.</li> <li>VI. RTD cards: 8 channels max.</li> </ul>
vi.	Redundancy Level	a. Controller b. Network c. Power supply d. Communication card e. Sever f. Operating Station
vii.	Loading	a. Controller loading shall be less than 50% b. Network loading shall be less than 50%
viii.	Spare philosophy	a. 20% prewired spare channel of each type card. b. 20% prewired spare card of each type. c. 20% prewired spare slots of each type.

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## 6.0 CABLING

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Field mounted electrical instruments should be wired and connected to the identified junction boxes.



Instrument wiring between the control room building and field junction boxes should be by means of multicore / multipair cables.

Note: After final installation of the plant, 20% spare shall remain in the multicore / multi pair cables for future use.

All Cables shall be FRLS unless otherwise specified.

- 6.1** The electrical signal cables shall comply with the following minimum requirement:
- 6.1.1 All conductors shall be stranded, the minimum conductor section shall be 1.5 mm<sup>2</sup> for wires Connected to individual instruments and 1.0 mm<sup>2</sup> size,
- 6.1.2 Individually and overall screened for wires in multicore cables.
- 6.1.3 All signal wires shall be twisted in pairs, triads or quads (twist will be at least thirteen (13) times per meter).
- 6.1.4 Single cables shall have a screening of metallic tape with a drain wire.
- 6.1.5 Cables shall be properly protected where required, e.g. on hydrocarbons ingress, mechanical damage.
- 6.1.6 All cables shall be water, oil and sunlight resistant, gas and vapor tight and flame retardant.
- 6.1.7 Insulation materials shall be PVC as per IS 5831.
- 6.1.8 Mineral insulated cables may be considered for high temperature service (e.g furnace, reactors etc.).
- 6.1.9 Instrument cable shall be specified as per Indian or IEC standards
- IS 5831
  - IS 3975
  - IS 1554, part 1
  - IS 8130
  - IEC 227-1
  - IEC 228
- 6.1.10 Cable armor shall be galvanized steel wire as per IS 3975.

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6.1.11 Mineral insulated Pyrotenax cable to be used.

6.1.12 All cables shall be rodent proof.

6.1.13 Following characteristics of cable are to be maintained:

- Maximum DC resistance of the conductor of finished cable shall not exceed 12.3 ohm/km at 20°C for cables 1.5 mm<sup>2</sup> conductor and 39.7 ohm/km at 20°C for cables with 0.5 mm<sup>2</sup>.
- Capacitance
- Mutual capacitance for PVC insulated cable between pair and adjacent core shall not exceed 250pF/meter at frequency of 1KHz.
- For Poly-Ethylene insulated cable-100 pF/ meter at 1KHz.
- Between core and screen- 400 pF/meter.
- L/R ratio between adjacent core shall not exceed 40 micro Henry/ohm for cables with 1.5 mm<sup>2</sup> and 25 micro Henry/ohm for 0.5 mm<sup>2</sup> cable.
- Drain wire resistance including shield not to exceed 30 Kohm/km.
- Electrostatic noise reduction ratio shall be over 76 dB.

6.1.14 In high temperature applications, Heat resistant cable shall be used up to distant junction box to be installed at ambient temperature.

6.1.15 Analogue and digital cable shall be same type.

6.1.16 High temperature cables for Heater/ Furnace area shall be considered upto junction boxes, junction boxes to be installed away from heat zone.

**6.2** All electric signal cables shall be installed and terminated observing the following details:



6.2.1 Special signals cables (such as coaxial cables, fiber optic etc.) shall be installed in accordance with the seller's instructions.

6.2.2 All signal cables shall be individually marked at both ends with plastic markers.

6.2.3 Special attention shall be paid to the interconnection of cable screens, such that the screening is earthed at the Panel/rack/cabinet end only so that multiple earthing does not occur.

6.2.4 Cable glands on equipment in the plant should be mounted at the bottom and never in the top, to prevent ingress of water. Where cable glands are installed in

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the side wall of the equipment, the cables shall enter from below. Cables coming from above shall first drop to below the elevation of the gland.

- 6.2.5 All cables used for intrinsically safe signals shall be identified as such. These cables shall have a light blue color. Non-intrinsically safe signal cables shall be Grey in color.
- 6.2.6 All field signal cabling shall be coded with the applicable instrument tag number close to the junction box.



### **6.3 Cable Entry Sealing**

- 6.3.1 Where cables have to be led through exterior walls or partitions with a fire blocking, water blocking or sealing function, gastight cable transits shall be installed.
- 6.3.2 The cable transits should be well accessible with respect to mounting, inspection and testing for leaks.
- 6.3.3 The spare space to be kept in the cable transits should correspond to the spare space on the cable ladders, but should at least be such that after final assembly 20% additional cables can be led through.
- 6.3.4 All cable and cabinet entries through the floors shall be sealed with polyurethane foam. Sealing material shall be fire retardant/fire proof.
- 6.3.5 MCT blocks shall be designed for cable entry to satellite building .Frame sizes of MCT blocks shall be standardized with 20% spare to be considered while designing.

## **7.0 JUNCTION BOXES**

- 7.1 Two types of junction boxes to be used.
- 7.2 One is for intrinsically safe connections with enclosure IP 65.
- 7.3 Another is explosion proof type with weather proof enclosure IP 65, to be used for solenoid valves.
- 7.4 If explosion proof type junction boxes are considered, then Code IIC for hydrogen and IIA/IIB for other to be certified.

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- 7.5 For non- intrinsically safe loops, explosion proof junction boxes shall be used in hazardous area.
- 7.6 Junction boxes shall be fiber glass or Cast aluminum or steel metal.
- 7.7 Cable glands for explosion proof type junction boxes shall be explosion proof.
- 7.8 NPT cable entry (e.g. ½"NPT) shall be considered for all field instruments and explosion proof (EExd) junction boxes (metal body).